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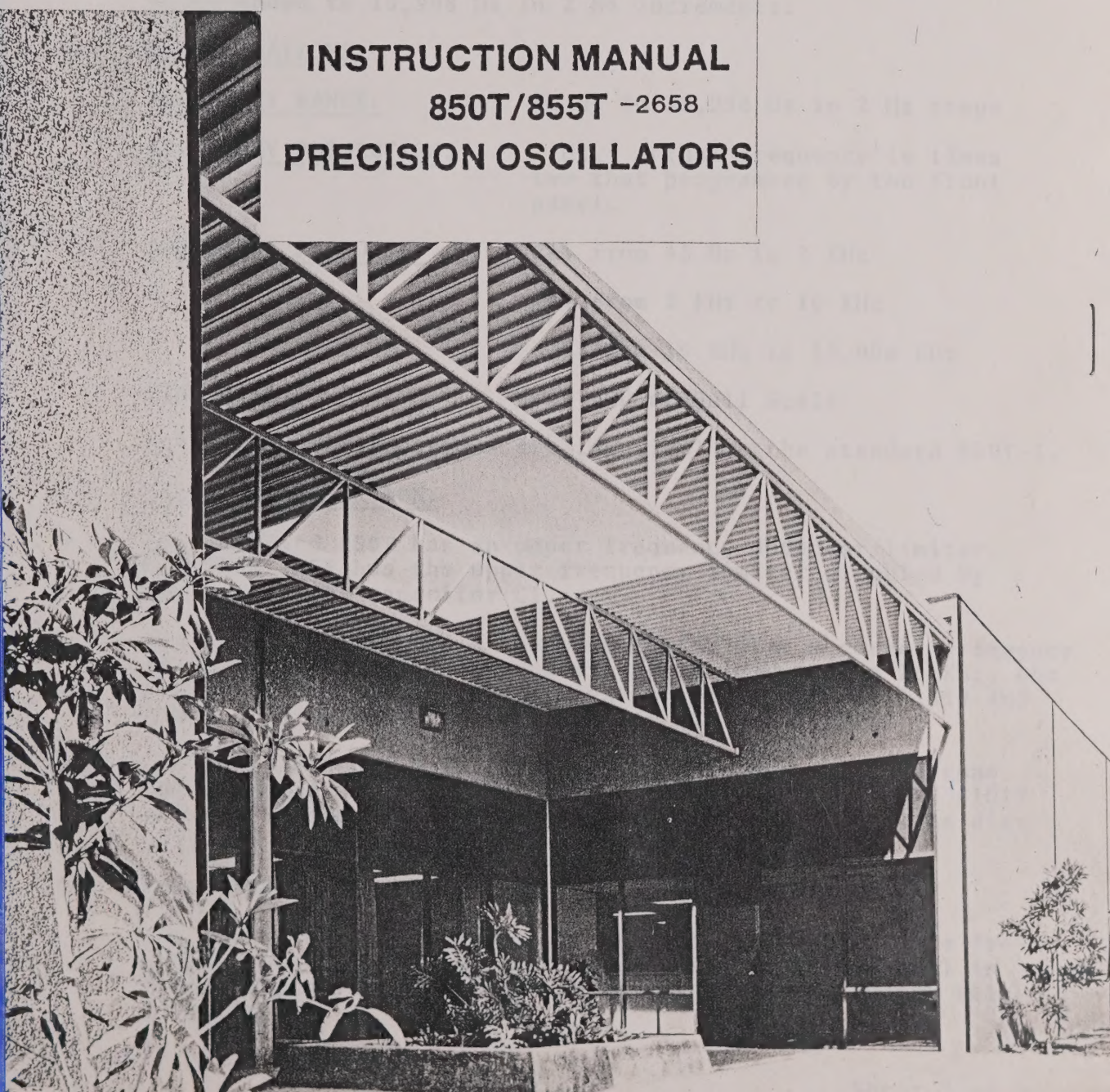
INSTRUCTION MANUAL
850T/855T -2658
PRECISION OSCILLATORS



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MANUAL ADDENDUM

Model 850T-2658

1.0 GENERAL:

The 850T-2658 is similar to a standard single-phase 850T Oscillator except the frequency range of the 850T-2658 is extended to 19,998 Hz in 2 Hz increments.

2.0 SPECIFICATIONS:

FREQUENCY RANGE:	45 Hz to 19,998 Hz in 2 Hz steps
FREQUENCY RESOLUTION:	2 Hz. Actual frequency is times two that programmed by the front panel.
FREQUENCY RESPONSE:	±1% from 45 Hz to 2 KHz
	±2% from 2 KHz to 10 KHz
	±3% from 10 KHz to 19.998 KHz
DISTORTION:	≤2% THD at Full Scale

All other specifications are identical to the standard 850T-1.

3.0 THEORY OF OPERATION:

3.1 The standard 850T has an upper frequency detector/limiter. The 850T-2658 has the upper frequency limiter disabled by the removal of capacitor C1.

3.2 The standard 850T has a low-pass filter with a corner frequency of 40 KHz. To maintain good frequency response to 20 KHz, the filter is disabled by the removal of A1C19, A1C20, A1R19 and A1R18. A jumper is substituted for A1R19 and A1R18.

3.3 The 850T-2658 has only 510 steps in the sine wave, whereas the standard 850T has 1020 steps. The 850T-2658 PROMS A1U17 and A1U19 were reprogrammed and the output of U20-3 was disabled to reduce the number of steps to 510.

4.0 OPERATION:

The actual output frequency of the oscillator is X2 the frequency set on the front panel switches. Review Table 1 to find examples of the "front panel vs. output frequency relationship.

5.0 TEST:

Program the frequencies given in Table 1. Verify the output frequency is that given in Table 1 ±.005%.

6.0 CALIBRATION:

Calibrate the 850T-2658 according to Section 4 of the standard 850T instruction manual.

7.0 PARTS LIST:

The following parts supersede PL4850-700:

C1	Not used
C19	Not used
C20	Not used
R5	100K 1% SN 560573
R18	10 5% SN 510005
R19	10 5% SN 510005
U17	CIC 207-5 SN CIC 207-5
U19	CIC 207-6 SN CIC 207-6

TABLE 1

Decade Switches	Range	Output
9999	X100	19,998 Hz
9999	X10	1,999.8 Hz
9999	X1	199.98 Hz
0030	X100	0060 Hz
0300	X10	060.0 Hz
3000	X1	60.00 Hz
3050	X1	61.00 Hz
3005	X1	60.10 Hz

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SECTION I—DESCRIPTION

1.1 INTRODUCTION

This instruction manual contains information relative to the installation, operation, calibration and maintenance of California Instruments 850T/855T Series Precision Oscillators. A detailed theory of operation is provided as an aid for maintenance personnel. A complete parts listing, schematic and component location diagrams are also supplied.

1.2 MODEL NUMBER DESCRIPTION

All oscillators in the 850T/855T Series have a five place model number which describes the oscillator series and the number of output phases. In addition, a "D" is placed after the model number if the oscillator is to be used in the three-phase, open delta configuration. The following examples illustrate this numbering system.

Example 1: 850T-1.

This is a variable frequency oscillator with single phase output.

Example 2: 850T-3D

This is a variable frequency oscillator with two-phase 60° open delta output (Phase C leading Phase A).

Example 3: 855T-2.

This is a fixed frequency oscillator with two-phase outputs, 90° displaced. (Phase C leading Phase A).

Example 4: 855T-3.

This oscillator is fixed frequency with three-phase wye output connections.

NOTE

Although the 855T is designated as a fixed frequency oscillator and will be set to the customer specified frequency, internal switches permit reprogramming the oscillator frequency.

1.3 GENERAL DESCRIPTION

California Instruments' 850T Series variable frequency oscillators and 855T Series fixed frequency oscillators are designed to plug into and derive their power from any of the Invertron® AC Power Sources. The output of the oscillator then provides the input frequency and amplitude drive for the Power Source. They employ digital logic techniques for frequency generation with a crystal controlled oscillator serving as the reference for the digital logic circuits. This technique provides long term frequency stability not obtainable with analog circuits. The 850T Series has three frequency ranges selected with a front panel switch. There are four frequency selection controls, permitting precise adjustment of the output frequency with resolution of one part in ten-thousand. Frequency is adjustable in 0.01 Hz steps from 0.01 Hz to 99.99 Hz in the X1 range, in 0.1 Hz steps from 0.1 to 999.9 Hz in the X10 range and in 1 Hz steps from 1 to 9999 Hz in the X100 range. By setting the internal switches and making other minor internal changes to the 855T, its output frequency may be similarly adjusted to any frequency selectable in 1 Hz steps.

The crystal oscillator reference has an average frequency stability of five parts per million per degree Centigrade. Thus, with the frequency having been set at room temperature, the maximum variation would be approximately 125 parts per million (0.0125%) over the 0 to 55°C range. The oscillator frequency is divided by digital logic circuits to the selected output frequency and then filtered to remove harmonic components.

The 850T/855T Series Oscillators will shut down if the frequency is outside of factory set limits. This prevents selection of a frequency outside the operating limits of the associated power source, in the case of the 850T, and protects against a malfunction of the oscillator circuits that would produce a frequency outside these limits.

The 850T/855T Series Oscillators are equipped with a "soft start" feature that slowly increases the output amplitude from zero to the set level whenever the

unit is first turned on. The 850T also "soft starts" when resuming operation after automatic shutdown caused by selection of an out-of-limit frequency.

Both the 850T and 855T Oscillators may be equipped with optional circuit boards to provide two- or three-phase outputs. Additionally, the output phases may be set to any 30 degree increment relative to the reference phase. Because of the digital techniques employed, the electrical angle between phases remains constant irrespective of frequency.

1.4 ACCESSORY EQUIPMENT

An Extender Assembly, Part No. 4800-703 is available for use with the 850T/855T Series Oscillators, permitting test and adjustment outside the associated power source.

1-5 SPECIFICATIONS AND PERFORMANCE DATA

Specifications and performance data for the 850T/855T Series Precision Oscillators are listed in Table 1-2. All units are factory tested to these specifications in accordance with California Instruments Division test procedures as detailed in Section V of this manual.

Table 1-2. Specifications.

FREQUENCY RESOLUTION:	1 part in 10,000
FREQUENCY ACCURACY:	0.005% at 23°C
FREQUENCY STABILITY:	5 ppm per °C.Average Temperature coefficient from 0 to 55°C.
FREQUENCY RESPONSE:	±1% from 45 Hz to 1 KHz. ±2% from 45 Hz to 5 Khz. ±3% from 45 Hz to 10 KHz.
AMPLITUDE STABILITY:	±0.1% for 24 Hrs at 23°C.
AMPLITUDE TEMPERATURE COEFFICENT:	0.02% per °C Average temperature coefficient from 0 to 55°C.
TOTAL HARMONIC DISTORTION:	0.3% max. on 855T and on X100 range of 850T. 0.15% on other ranges at full output.
PHASE ACCURACY:	
Two Phase:	90° 1° from 45 Hz to 5 KHz. 90° 2° from 5 Khz to 10 KHz. (Phase C leading Phase A)
Three Phase Delta:	60° 1° from 45 Hz to 5 KHz. 60° 2° from 5 KHz to 10 KHz. (Phase C leading Phase A).
Three Phase Wye:	120° 1° from 45 Hz to 5 KHz. 120° 2° from 5 Khz to 10 KHz.
GENERAL:	
Size:	Standard Plug-In size for all Invertron™ AC Power Supplies.
Input Power:	Available from associated Invertron™ AC Power Sources.
Front Panel Finish:	Gray, 26440 per Federal Standard 595 with black silk screened lettering.

CAUTION

Voltages up to 500 Volts AC are available in certain associated Invertrons®. This equipment generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with connector pins C and D of the plug-in oscillator, the primary power circuits and output circuits of the associated Invertron® if oscillator is tested and/or adjusted with Invertron®.

SECTION II
INSTALLATION AND OPERATION

2.1 UNPACKING

Individual oscillators are shipped in cardboard containers with protective inner packing. Do not destroy this packing container until the unit has been inspected for possible damage in shipment.

2.2 POWER REQUIREMENTS

The California Instruments 850T/855T Series Precision Oscillators operate from +25 volts DC and −25 volts DC at 0.040 amperes. In addition, 115 volts AC at 10 volt-amperes is required. These power inputs are normally obtained from an associated Invertron® power source.

2.3 FUSE REQUIREMENTS

Separate fusing of the power sources for the California Instruments 850T/855T Series Oscillators is not required.

2.4 ACCEPTANCE TEST PROCEDURE

Inspect the unit for any possible shipping damage immediately on receipt. If damage is evident, notify carrier. **DO NOT return an instrument to the factory without prior approval.** If the unit appears to be in good condition, perform the following:

Mount the oscillator in the appropriate rack housing or, otherwise, apply +25 volts DC, −25 volts DC and 115 volts AC to the unit.

2.4.1 MODEL 850T SINGLE-PHASE OSCILLATORS

The output of a single-phase oscillator should be variable from 0 to 5.000 volts measured between pins 2 and 8 (ground) of connector J2. There is no upper level adjustment. Frequency should be variable in 0.01 Hz steps from 0.01 Hz to 99.99 Hz with the RANGE switch in the X1 position, in 0.1 Hz steps from 0.1 to 999.9 Hz with the switch in the X10 position and in 1 Hz steps from 1 to 9999 Hz with the switch in the X100 position. When monitored with an oscilloscope, distortion should not be visible. Detailed test procedures are provided in the TEST PROCEDURE section of this manual. They should be consulted if further evaluation of the oscillator is required at this time.

2.4.2 MODEL 850T TWO-PHASE OSCILLATORS

The details of paragraph 2.4.1 apply to the reference phase of these oscillators. The phase C (ϕC) output, measured between pins 8 and 9 of J2, should have the same amplitude as the ϕA output (± 0.05 volts) at any position of the front panel amplitude control. When monitored with an oscilloscope, distortion should not be visible on any phase. Detailed test procedures are provided in Section IV of this manual. They should be consulted if further evaluation of the oscillator is required at this time.

2.4.3 MODEL 850T THREE-PHASE OSCILLATORS

The details of paragraph 2.4.1 apply to the reference phase of these oscillators. The phase B (ϕB) output, measured between pins 7 and 8 of J2, and the phase C (ϕC) output, measured between pins 8 and 9 of J2, should have the same amplitude (± 0.05 volts) as the A output at any position of the front panel amplitude control. When monitored with an oscilloscope, distortion should not be visible on any phase. When monitored with a phase meter, the angle between the ϕB and ϕC outputs should be 120°. Detailed test procedures are provided in Section IV of this manual. They should be consulted if further evaluation of the oscillator is required at this time.

2.4.4 MODEL 855T SINGLE-PHASE OSCILLATORS

The details of paragraph 2.4.1 apply to these oscillators except that the frequency is fixed at that indicated in the manual addendum.

2.4.5 MODEL 855T TWO-PHASE OSCILLATORS

The details of paragraph 2.4.2 apply to these oscillators except that the frequency is fixed at that indicated in the manual addendum.

2.4.6 MODEL 855T THREE PHASE OSCILLATORS

The details of paragraph 2.4.3 apply to these oscillators except that the frequency is fixed at that indicated in the manual addendum.

2.5 MECHANICAL INSTALLATION AND WIRING

The 850T/855T Series Oscillators fit directly into the California Instruments Solid State Invertron® Series of power amplifiers. All power for the oscillator, as well as signal output(s) is coupled through the printed circuit connector at the rear of the oscillator. Table 2-1 lists the voltages and applicable connector pins.

Table 2-1. Input/Output Connections.

PIN	FUNCTION
1	Phase A Output signal low
2	Phase A Output signal high
3	Power ground
4	+25 volt input
5	−25 volt input
6	Phase B signal output low
7	Phase B signal output high
8	Phase C signal output low
9	Phase C signal output high
10	External sync input
C	115 volts AC line high
D	115 volts AC line low

The single phase versions of the 850T and 855T Series Oscillators have only a ϕA output. The two-phase (multiphase) versions have ϕA and ϕC outputs while the three-phase verisons have ϕA, ϕB and ϕC outputs.

The oscillators require 115 volts AC, which is rectified, filtered and regulated to 5 volts DC for powering the digital circuitry.

2.6 OPERATING CONTROLS

The 850T Series oscillators have four frequency selector dials on the front panel with which each digit of the output frequency is individually selected. An AMPLITUDE control varies the output level of all signal outputs from 0 to 5.0 volts. The 855T Series oscillators, being fixed frequency, have only the AMPLITUDE control on the front panel.

The output signals of the multi-phase and three-phase versions of both the 850T and 855T are factory adjusted for equal amplitude of all three phases. The GAIN control on each power amplifier of a multi-phase or three-phase system is used as a trim control to adjust each of the output leg voltages so that they are precisely equal to each other.

CAUTION

REMOVE POWER FROM THE SOLID STATE INVERTRON® BEFORE REMOVING OR INSERTING THE PLUG-IN OSCILLATOR.

SECTION III
THEORY OF OPERATION

3.1 GENERAL

The California Instruments 850T/855T Series Precision Oscillators, because they are controlled by a quartz crystal, provide a degree of frequency stability that surpasses, by an order of magnitude, that which is obtainable with analog types. Amplitude stability is also improved since the operating frequency is determined by digital logic circuits. Therefore, the basic "oscillator" is not frequency or temperature sensitive. Output amplitude stability will be affected mainly by frequency and temperature as they affect output amplifiers. Such affects are minimal. The optional multi-phase outputs of this series are developed through a single phase to multi-phase converter.

3.2 FUNCTIONAL DESCRIPTION

The functional descriptions of this section describe the circuitry of the Model 850T oscillator. The Model 855T operates in exactly the same manner except that the frequency is programmed with internal switches and is not variable at the front panel.

3.2.1 PHASE A GENERATOR

3.2.1.1 BASIC OSCILLATOR

The following paragraphs present a functional description of the basic oscillator referenced to the block diagram of Figure 3-1. The crystal oscillator operates at 10.2 MHz. A group of four rate mul-

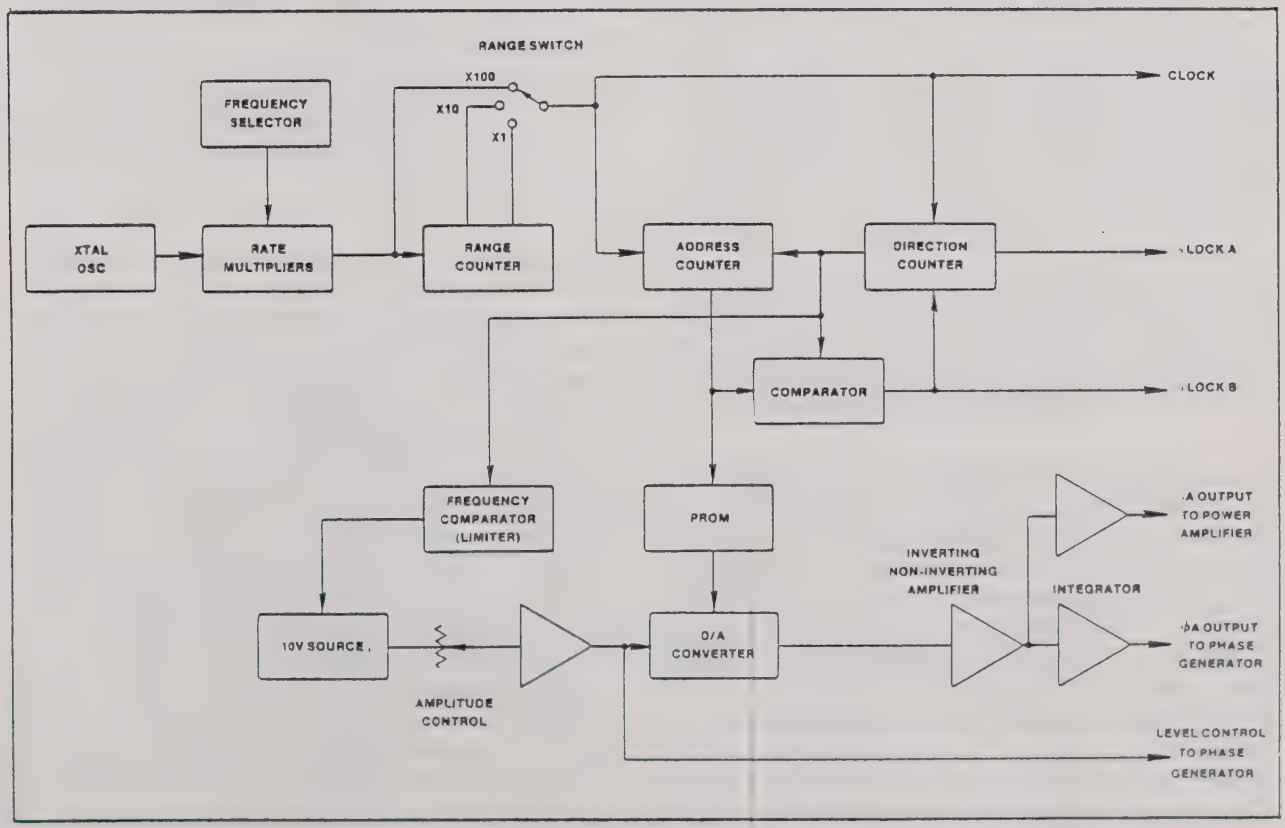


Figure 3-1. Block Diagram, ϕA Generator (Main Board).

tipliers, connected in series, control the number of oscillator pulses that will pass to their output per unit time. That number is dependent on the positions of the four panel rate (frequency) switches to which the rate multipliers are connected. Though not dividers, in the usual sense, the rate multipliers effectively divide the oscillator frequency in accordance with the panel switch settings.

The pulses at the output of the rate multipliers pass to a dual decade counter and the range switch. When the switch is in the X100 position, the rate multiplier output passes through the switch directly to the address counters. When it is in the X10 position, the rate multiplier output is divided by 10 through one half of the dual decade counter before passing to the switch and to the address counters. When it is in the X1 position, it is divided by 100 through both halves of the dual counter before passing to the switch and the address counters. This arrangement permits division of the crystal oscillator by multiplication using factors ranging from 0.001 to 0.9999. The ranges of multiplication, determined by the range switch position, are 0.001 to 0.009999, 0.01 to 0.09999 and 0.1 to 0.9999.

The address counter consists of two binary counters. The four outputs of each counter are connected to inputs of the programmable read-only memory (PROM) which would provide 256 discrete addresses. However, the number of addresses is limited to 255 as the comparator and the direction control counter cause the address counter to change its count mode from up to down at counts 255 and 765 and from down to up at counts 510 and 1020. During each complete cycle, at the output frequency, the counters count up from 000 to 255 for the first 255 clock pulses, count down to 000 during the time of clocks 256 to 510, back to 255 during the time of clocks 511 to 765 and back to 000 during the time of clocks 765 to 1020.

At each of the 255 addresses produced by the address counters, a discrete digital code appears at the output of the PROM and at the input to the digital-to-analog converter (D/A converter). As the address to the PROM progresses from 000 to 255, the PROM output codes cause the output of the D/A converter to increase in 255 steps that describe the first 90 degrees of a sinusoidal waveform. As it progresses from 255 to 000, while the counter is counting down, the second 90 degrees of a sinusoidal waveform are described. The absolute levels at the D/A converter output are determined by the 10 volt reference and the adjustment of the level control.

The waveform at the output of the D/A converter is similar to that of a sinusoidal waveform after full wave rectification except that it is generated in 510 steps (digitally) rather than as an analog signal. To formulate a quasi-sinusoidal waveform, alternate portions of the D/A converter output must be inverted. Alternate clockings of the direction control counter produce a state change at its output that is connected to the inverting/non-inverting amplifier. The state of the counter output determines whether the amplifier will be in its inverting or non-inverting mode. Since the counter output changes state at the end of each half-cycle, alternate half-cycles of the D/A converter output are inverted and the output of the amplifier is a quasi-sinusoidal waveform which is filtered by the integrating amplifier to produce a sinusoidal waveform with very low distortion.

The frequency limiter serves to prevent an output from the oscillator if the selected frequency is outside of the range of the associated power source driven by the 850T. The frequency limits are factory adjusted. The limiter consists of two timers. One limits the upper frequency and the other the lower frequency. The signal that clocks the direction control counter also triggers both sections of the frequency limiter, once for each output cycle. If the frequency is too low, one timer will have timed out before the next trigger pulse occurs. This is sensed and disables the 10 volt reference for the D/A converter, thus shutting off the output. If the frequency is too high, the second timer will not have timed out before the next tigger pulse. This, too, is sensed and also disables the 10 volt reference.

3.2.1.2 MULTI-PHASE OUTPUT GENERATOR

The reference phase, phase A (ϕA), is generated by the basic oscillator described functionally in the preceding paragraphs. Phases B and C (ϕB and ϕC) are generated on an optional second circuit board. The circuits of that board are shown in block diagram form in Figure 3-2. Note that there are similarities between Figures 3-1 and 3-2 in the counter-PROM-D/A converter areas. The address counters are clocked in the same manner as those of the basic oscillator. However, they are preset coincident with the zero degree point of the reference phase, ϕA, to a number corresponding to the difference between the reference phase and the desired angle of Phase C (ϕC). In the standard unit, this will be the equivalent of 120 degrees leading ϕA. The address counters, direction control counter, PROM, D/A converter and inverting/non-inverting amplifier operate in the same manner as those of the basic oscillator. The

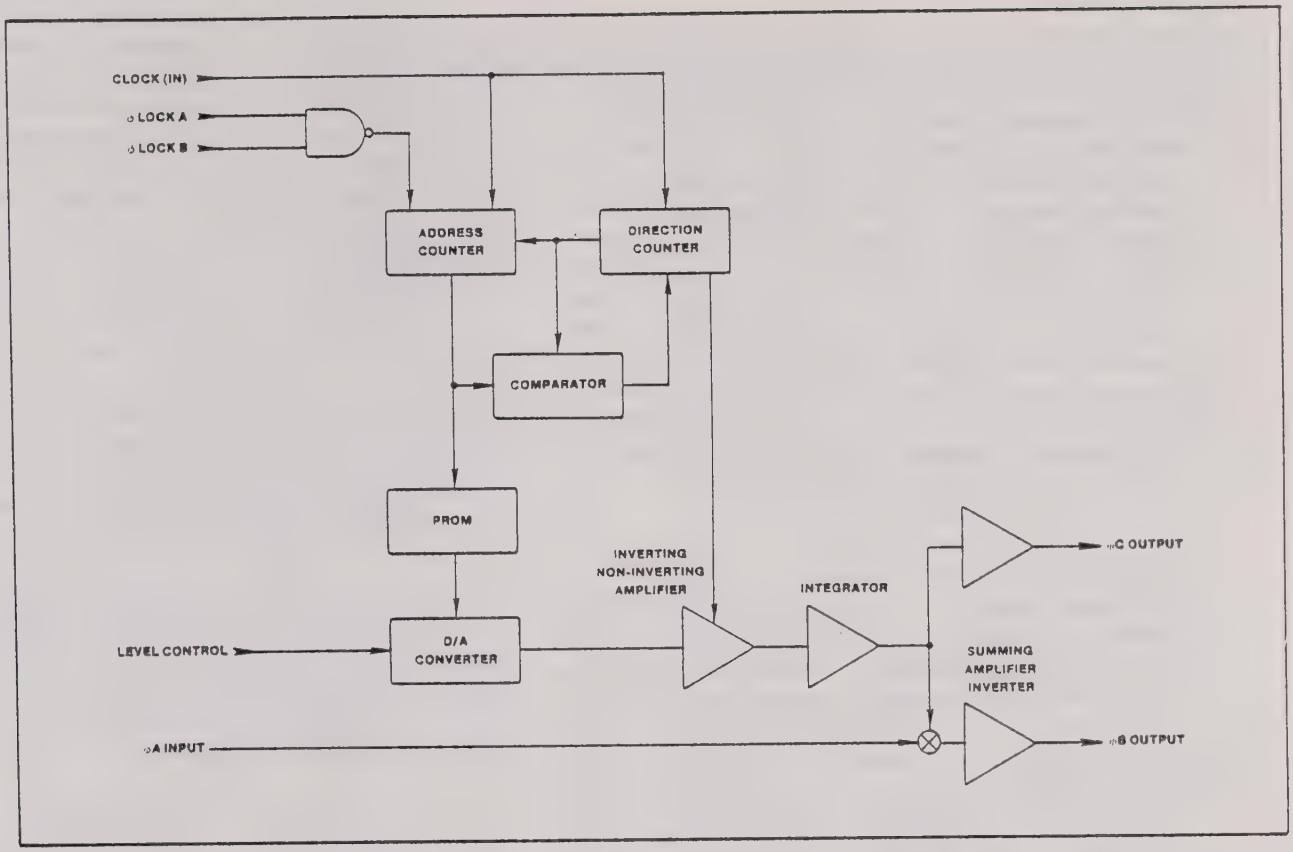


Figure 3-2. Block Diagram, Multi-Phase Generator Board.

output of the ϕC inverting/non-inverting amplifier is combined with the ϕA output in the phase B (ϕB) generator to create the ϕB output.

3.3 DETAILED CIRCUIT DESCRIPTION

The paragraphs of this section describe in detail the operation of the circuits of the Model 850T Precision Oscillator. Unless otherwise specified, all text within this section is referenced to the schematic diagrams of Figures 6-4 and 6-7. Where components consist of several discrete circuits within a single package, the individual circuits are identified in the text by the basic component identifier followed by a hyphen and the output pin number. For example, the buffer in U7 that has its output connected to pin 8 is identified as U7-8. If this device is located on circuit board A1, its complete identifier is A1U7-8. However, the prefix is used in the following paragraphs only when necessary to avoid confusion in identifying similarly numbered components located on different boards.

3.3.1 PHASE A GENERATOR

3.3.1.1 CRYSTAL OSCILLATOR

Refer to Figure 6-3. Crystal Y1, FET Q3 and associated components comprise an oscillator operating at 10.2 MHz. The oscillator output is buffered by U7-8 and U7-10 which also convert the oscillator output to a series of TTL compatible pulses.

3.3.1.2 RATE MULTIPLIERS

A complete explanation of the operation of rate multipliers may be found in material published by the device manufacturer. Therefore, the explanation of the rate multiplier circuits herein is limited to that which is peculiar to this design.

A rate multiplier may block pulses appearing at its input from reaching its output or it may pass from one to nine pulses for every ten input pulses, depending on the states of its control inputs. In the 850T Series variable frequency oscillators, the control inputs of the rate multipliers, U1, U2, U3 and U4, are connected to the frequency control switches, S3, S4, S5 and S6. (In the fixed frequency models, they are connected to switches S1 and S2). Rate multiplier U1, for the most significant digit (MSD), is enabled at all times. From 0 to 9 pulses will appear at its output, pin 5, during the time of the first nine of each group of ten oscillator pulses. The actual num-

ber will depend on the setting of the frequency control switch, S6. During the time of the tenth oscillator pulse, its enable output, pin 7, goes low, enabling the next rate multiplier, U3. U3 counts the enable input pulses in the same manner that U1 counted the oscillator pulses. The number that pass to its output will be dependent on the setting of switch S5. However, the output pulse will have the timing and duration of the clock oscillator pulse because it is an input to each rate multiplier. This provides synchronization and uniformity of the pulses at the outputs of the mulitipliers. U4 counts the enabling outputs of U3 and U2 counts those from U4. The output pulses from the rate multipliers are then summed through NAND gate U8-8.

3.3.1.3 RANGE SELECTOR

The range selector circuit consists of dual decade counter U11 and selector switch S7. (S7 is installed only in variable frequency models). When S7 is in the X100 position, the pulses at the output of U8-8 pass directly to the address counters, U13 and U18, and to directional control counter U14. When S7 is in the X10 position, the pulses at the output of U8-8 are divided by a factor of ten in one-half of U11. When it is in the X1 position, they are divided by a factor of 100 through both sections of U11.

3.3.1.4 ADDRESS AND DIRECTION CONTROL COUNTERS

The address counters, U13 and U18, are so called since they produce the address for the two programmable memories (PROM's) U17 and U19. They are binary counters that are synchronously clocked by the output of U8-8 or by one of the outputs of U11, depending on the position of S7. However, U18 is enabled by the output of U13 only between the rising edges of the 15th and 16th clock pulses and will be clocked by the rising edge of the 16th pulse. Therefore, U13 must be clocked sixteen times for U18 to be clocked once, thirty-two times for it be clocked twice, etc. The four stage outputs of U13 and U18 are connected to the eight inputs of U17 and U19 providing 256 discrete memory addresses.

The array of exclusive NOR gates, U20 and U22, are open-collector types and their combined outputs go high, producing ϕLOCK B, when all its inputs are the same, high or low. ϕLOCK B occurs when U14-14 (Q0) is high and all stage outputs of U13 and U18 are high, except U13-14 (Q0), at counts 254 and 764. It also occurs when U13-14 is low and all stage outputs of U13 and U18 are low, except U13-14, at counts 509 and 1019. ϕLOCK B is an input to the optional multi-phase converter board and to counter U14. U14 is enabled through inverter U7-6 when ϕLOCK B goes high and is then clocked once simultaneously with U13 and U18 at clock pulses 255, 510, 765 and 1020. U13 and U18 are advanced one count, since their up/down inputs do not change state until after this clock pulse. The inputs to U20 and U22 are then no longer the same and ϕLOCK B goes high, disabling U14. However, U14 was clocked once, changing the state of its Q_0 output, pin 14, and the up/down inputs of U13 and U18. The count modes of U13 and U18 are then changed from up to down if pin 14 of U14 goes low or from down to up if it goes high. Thus U13 and U18 are forced to count up from count 001 to count 255, down from count 256 to 510, up from count 511 to 765 and down again from count 766 to 1020.

Counter U14-13 has its Q_1 output connected to FET Q7. The purpose of this connection is covered in a later paragraph. Its terminal count output, pin 15, goes low every 4060 counts to provide ϕLOCK A which is an input to the optional multi-phase converter board covered in paragraph 3.2.2.

3.3.1.5 QUASI-SINUSOID GENERATION

The digital-to-analog converter (D/A converter), U21, and the two amplifiers of U15 generate a quasi-sinsoidal waveform, consisting of 1020 discrete steps, in response to the inputs from programmable memories (PROM's), U17 and U19. The DC input for the D/A converter is provided by the 10 volt regulator, U10, and is adjusted for output level by R29 which is the front panel amplitude control.

The PROM outputs provide the digital input codes for the D/A converter. From the previous paragraphs, it should be apparent that the address for the PROM'S is being repeatedly incremented from 000 to 255 and then decremented from 255 back to 000. Thus, the digital input codes to the D/A converter are, likewise, being incremented and decremented. The PROM's are programmed so that, as their addresses are incremented from 000 to 255, their outputs cause U21 to produce what comprises the first 90 degrees of a quasi-sinusoidal waveform consisting of 255 discrete steps. The amplitude of each step is equivalent to:

$$\sin(90/255 \times A)$$

Where A is the discrete digital address (000 to 255).

As the address is decremented from 255 back to 000, U21 produces the opposite waveform which is the

second 90 degrees (91 to 180 degrees) of a quasi-sinusoidal waveform. The process of address incrementing and decrementing is repetitive. Therefore, in two complete cycles, U21 produces what appears as a sinusoidal waveform after full wave rectification except that it consists of 1020 discrete steps rather than being a pure analog signal. It is only necessary to invert alternate cycles of U21's output to achieve a quasi-sinusoidal waveform. This is accomplished in the amplifiers of U15.

FET Q7 grounds the connection between R27 and pin 3 of U15 whenever its gate is at +5 volts, changing the two sections of U15 from an inverting amplifier to a non-inverting amplifier. In a previous paragraph, it was stated that counter U14 was clocked once at counts 255, 510, 765 and 1020. Its Q_1 output, pin 13, therefore, will change state at counts 510 and 1020. Pin 13 of U14 is connected to the gate of FET Q7. Whenever it is low, Q7 is turned off and U15 inverts the output of U21. When it is high, Q7 is turned on and U21's output is not inverted. A complete cycle for U21 occurs between counts 000 and 510 and between 510 and 1020. Thus, alternate cycles will be inverted to form a quasi-sinusoidal waveform at the output of U15. R25 provides a means of equalizing the amplification of U15 in its inverting and non-inverting modes so that the alternate half-cycles of the quasi-sinusoidal waveform are equal in amplitude. The output of U15 is then integrated in U16-1 to provide a ΦA OUTPUT which is a sinusoidal waveform with very low distortion. The signal at pin 3 of U16 is sinusoidal and is passed through U16-7, which has unity gain, to provide the ΦA output of the oscillator.

3.3.1.6 FREQUENCY LIMITER

The purpose of the frequency limiter is to prevent production of an output frequency above or below the range of the AC power source that is driven by the 850T. Its circuit is shown in Figure 6-4 and is comprised of transistors Q1 and Q2, dual timer U6, dual flip flop U5, NAND gate U8-6 and associated components. The Q_1 output of counter U14 (pin 14) transitions from high to low once for every half-cycle of the output frequency. This pulse clocks both sections of U5, momentarily turns on Q1 and Q2 to discharge timing capacitors C1 and C2 and triggers both timers of U6. The section of U6 associated with Q2 is adjusted with R6 so that its time period is greater than one half-cycle of the lowest permissible output frequency. As long as the output frequency of the 850T is greater than this low limit, the output of the timer will be high when the next trigger pulse from U14 occurs. The Q output of flip flop U5-5 will not change state and the input of U8-6, connected to it, will remain high. The section of U6 associated with Q1 is adjusted with R1 so that its time period is less than one half-cycle of the highest permissable output frequency. As long as the output frequency of the 850T is less than this high limit, the output of the timer will have transitioned from high to low before the next pulse from U14 occurs. The Q output of U5-8 and the input to U8-5 connected to it will remain high.

While the frequency remains within the set limits, the output of U8-6 will be low (all its inputs are high) and Q6 will be turned off and Q8 will be turned on, completing the path from the +15 volt input to 10 volt regulator U10 which provides the DC input to D/A converter U21. If the selected frequency is below the set limit, pin 2 of U6 will go low before the next pulse. The Q output of U5-5 will be clocked low, the output of U8-6 will go high turning on Q6, turning on the LIMIT LED, CR5, turning off Q8, the DC supply to U10 and the D/A converter. If the selected frequency is higher than the set limit, pin 9 of U6 will be high at the time of the next pulse and the Q output of U5-9 will be clocked low, the output of U8-6 will go high turning on Q6, turning off Q8, the DC supply to U10 and the D/A converter.

A "soft start" feature is incorporated in the frequency limiter circuit that gradually increases the voltage applied to U10 when the unit is first started and whenever it returns to operation after shutting down because of an out-of-limit frequency condition. Q6 will be turned on when power is applied or when an out-of-limit frequency is selected. When it is turned off, R20 and C15 will delay the application of full forward bias to the base of Q8. Thus, the voltage applied to U10 will slowly increase from zero to +15 volts and the output of the D/A converter will, likewise, slowly increase.

3.3.1.7 POWER SUPPLIES

The +15 volt and −15 volt supplies are obtained by regulating the +25 and −25 volt supplies of the associated power source to those levels in the circuits of Q4 and Q5. The +5 volt supply is obtained from 115 volts AC through transformer T1, rectifiers CR3 and CR4 and +5 volt regulator U9.

3.3.2 MULTI-PHASE CONVERTER

The multi-phase converter is located on a separate, optional circuit board and the circuits of that board are shown in Figure 6-4. The multi-phase converter generates a phase C (ΦC) output from the ΦA input

which is then combined with the ϕA input to produce the ϕB output. A vector diagram showing the angular displacement of each phase with respect to the others is shown in Figure 3-3. The following paragraphs explain the functioning of the multi-phase converter.

3.3.2.1 PHASE C GENERATOR

The phase C generator consists of address counters, a directional control counter system, PROM's, a D/A converter and an inverting/non-inverting amplifier that perform the same functions as those on the ϕA generator board which were decribed in previous paragraphs. The circuits, comprised of counters U1, U2 and U3, exclusive NOR gates U7 and U8, PROM's U4 and U5, D/A converter U9 and operational amplifier U10 are interconnected in the same manner as their counterparts on the ϕA generator board. The counters are clocked by the same signal from A1U8-8 or A1U11. The DC input for the D/A converter is obtained from amplfier A1U12-6 which has its output level adjusted by the front panel amplitude control. Thus the amplitudes of the ϕA and ϕC outputs will be identical. R15 provides a fine adjustment of the ϕC amplitude.

The counters of the multi-phase converter, unlike those of the ϕA generator, are preset at the instant the ϕA output passes through the 180° point on every fourth cycle. The preset causes the waveform generated in this system to be displaced, relative to ϕA such that it lags ϕA by 120 degrees. The preset is accomplished by $\overline{\phi\text{LOCK A}}$ and ϕLOCK B through U6-8 and U6-11. $\overline{\phi\text{LOCK A}}$ goes low one clock pulse prior to the end of every fourth cycle of the output frequency (4078 clock pulses from the output of A1U8-8 or A1U11) and remains low for the next complete cycle. ϕLOCK B, as described in preceding paragraphs, goes high at counts 254, 509, 764 and 1019. Therefore, it goes high at counts 2039, 3059 and 4079. When $\overline{\phi\text{LOCK A}}$ is low and ϕLOCK B goes high, the preset mode of counters U1, U2 and U3 are enabled and preset occurs on the rising edge of the next clock pulse. The counters are preset to the count determined by the connections to their A, B, C and D inputs. S1 is not normally installed and the dotted lines across its sections 2 and 4 represent clad jumpers on the circuit board. As drawn, the A and C inputs of U1 and U2 are grounded (low) and the B and D inputs are at +5 volts. This produces a preset of AA in hexidecimal or 1010 1010 in binary. This presets the PROM address at 170. The directional control counter, U3, is preset so that its Q_A output is low and its Q_B output is high. Thus, counters U1 and U2 will be in the count down mode and U10 will be in its inverting mode. The amplitude of the waveform developed at the output of U9 from this point forward will be decreasing from maximum and, since U10 is in an inverting mode, the output of U10 will be 120° leading ϕA which is the correct phase angle for ϕC. The signal output of U10 is buffered by U12-7 to provide ϕC OUTPUT at pin 14 of J1. Capacitor C8 provides high frequency roll-off for U12-7.

3.3.2.2 B PHASE GENERATOR

The ϕB signal is obtained by summing ϕA and ϕC signals of equal amplitudes and then inverting the resultant signal through an operational amplifier. The ϕA OUTPUT signal input to this board is obtained from amplifier A1U16 which isolates it from the ϕA OUTPUT signal to the power source which is obtained at the output of A1U16-7. The ϕC signal is obtained from the output of amplifier U12-1. The two signals are summed at the input of amplifier U11-1 through the resistor network of R11 and the two sections of R3. R11 provides a fine adjustment of the ϕB angle and R7 provides a fine adjustment of the ϕB amplitude. The ϕB is buffered in U11-7 to produce ϕB OUTPUT at pin 13 of J1.

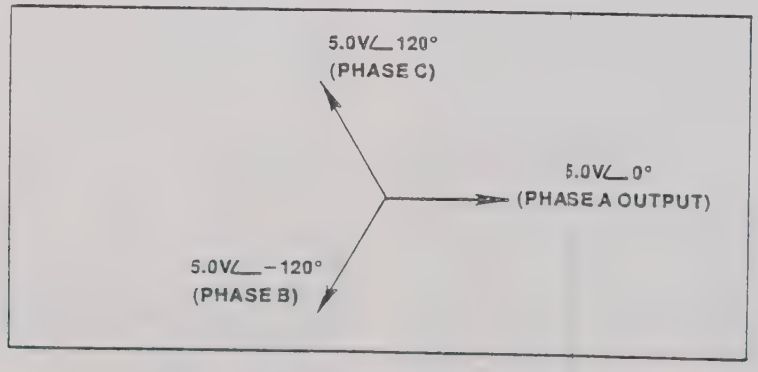


Figure 3-3. Three Phase Vector Diagram.

SECTION IV
ADJUSTMENT PROCEDURES

4.1 GENERAL

The following adjustment procedure, or any part of it, may be performed on a routine basis to insure that the oscillator remains within the specified performance limits. The procedure should always be performed after service to the oscillator.

The procedure outlines calibration of the main board (A1) which controls output frequency and phase A (ϕA) distortion, and of the Phase Board (A2) which controls the phase B (ϕB) and phase C (ϕC) amplitude and distortion.

Calibration of either the 850T or 855T Series Oscillators requires a test fixture or compatible power sources as shown in Figure 4-1. An extender accessory, Part No. 4800-703, may be used if the oscillator is to be calibrated while connected to an Invertron® power source.

4.2 PROCEDURE

4.2.1 SINGLE PHASE MODELS

4.2.1.1 DISTORTION

Connect a distortion analyzer between pin 2 and pin 8 (ground) of connector J2. If the oscillator is connected to the power source, the output of the power source may be monitored with the distortion analyzer. Adjust the front panel AMPLITUDE control to produce 5 volts RMS at the output of the oscillator, pin 2 of J2, or for full scale output of the power source. Adjust potentiometer A1R25, on the main board, for indication of lowest distortion content.

Reduce the front panel AMPLITUDE control to produce 1 volt RMS at the oscillator phase A output. Adjust A1R24 for the lowest distortion level.

CAUTION

Voltages up to 500 Volts AC are available in certain associated Invertrons®. This equipment generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with connector pins C and D of the plug-in oscillator, the primary power circuits and output circuits of the associated Invertron® if oscillator is tested and/or adjusted with Invertron®.

4.2.2 TWO-PHASE MODELS

The distortion adjustment must be made prior to the

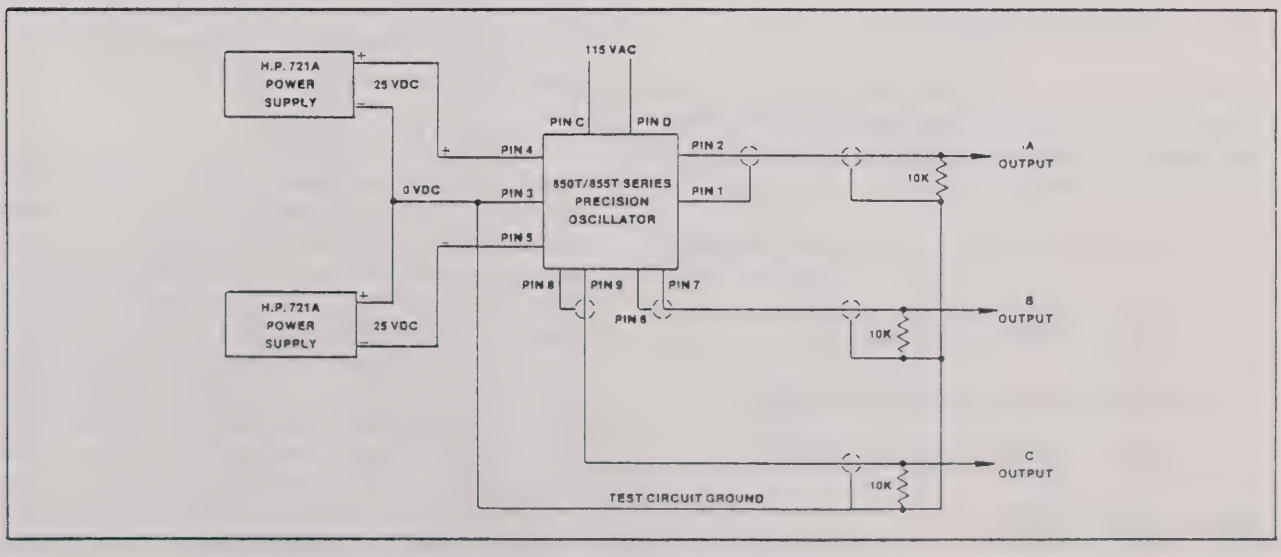


Figure 4-1. Test Circuit for 850T/855T Series Oscillators.

LEVEL adjustment of 4.2.2.2 because of interaction of the adjustments.

4.2.2.1 DISTORTION

A. Connect a distortion analyzer between pin 2 and pin 8 (ground) of connector J2. If the oscillator is connected to the power source, the ϕA output of the power source may be monitored with the distortion analyzer. Adjust the front panel AMPLITUDE control to produce 5 volts RMS at the output of the oscillator, pin 2 of J2, or for full scale output of the power source. Adjust potentiometer A1R25, on the main board, for indication of lowest distortion content.

B. Connect the distortion analyzer between pin 9 and pin 8 (ground) of connector J2. If the oscillator is connected to the power source, the ϕC output of the power source may be monitored with the distortion analyzer. Adjust potentiometer A2R14, on the phase board for an indication of lowest distortion content in the ϕC output.

Reduce the front panel AMPLITUDE control to produce 1 volt RMS at the oscillator phase C output. Adjust A2R13 for the lowest distortion level.

4.2.2.2 AMPLITUDE ADJUSTMENT

Connect an AC digital multimeter between pins 2 an 8 of J2 (A). Adjust the front panel amplitude control for 5.00 volts RMS. Connect the AC digital multimeter between pin 9 and pin 8 of J2. Adjust A2R15 for 5.00 ± 0.05 volts.

4.2.3 THREE-PHASE MODELS

There is some interaction in the following adjustments. For the correct alignment of the three-phase oscillators, the following adjustments must be made in the order shown:

A. Adjust the ϕA and ϕC distortion as directed in 4.2.2.1.

B. Adjust the level of ϕC relative to ϕA.

C. Adjust the phase angle of the ϕB output.

D. Adjust the amplitude of ϕB relative to ϕA.

4.2.3.1 DISTORTION

Perform the tests outlined in paragraphs 4.2.2.1 and 4.2.2.2.

4.2.3.2 PHASE ADJUSTMENT

A. Connect the differential phase meter between pins 2 (A), 7 (B) and ground. Adjust the frequency of variable frequency models (850T) to 100 Hz, or less. Adjust potentiometer A2R11 on the Phase Board (A2) for a phase meter indication of A leading B by 120 degrees.

4.2.3.3 AMPLITUDE ADJUSTMENT

A. Monitor the ϕA output of the oscillator with an AC digital multimeter connected between pins 2 and 8 (ground) of connector J2. Adjust the front panel AMPLITUDE control for a 5.0 volts RMS reading.

B. Connect the digital multimeter to pin 7 of connector J2. Adjust potentiometer A2R7 on the Phase Board for a 5.0 volts RMS reading.

4.2.4 FREQUENCY LIMIT ADJUSTMENT

The frequency limiter prevents the 850T/855T Series Oscillators from driving the associated power source with a frequency that is outside the power source operating limits. If the dials of the 850T are set at a frequency outside those limits, or if the frequency determining circuits should malfunction, the output of the oscillator will be shut off and a red LIMIT indicator on the front panel will light. The LIMIT indicator will be extinguished and the output will be turned back on when the dials are set to a frequency within the power source limits. The limiter is also a feature of the 855T and safeguards against a malfunction of the frequency determining circuits. The standard adjustment permits oscillator operation between the limits of 45 Hz and 5000 Hz. If a wide-band power source is to be driven by either oscillator, the limits may be readjusted.

4.2.4.1 850T ADJUSTMENT

To adjust the lower frequency limit, set the RANGE switch to X100 and select the highest frequency desired. Adjust potentiometer A1R1 on the main board (A1) to the point where the LIMIT indicator is illuminated then back off on the adjustment slightly. Select a frequency higher than the set limit and verify LIMIT indicator illumination. Similarly, set the lower limit frequency and adjust A1R6 for LIMIT indicator illumination then back off on that adjustment slightly. Select a frequency lower than the set limit and verify LIMIT indicator illumination. When adjusting the limit potentiometers, note that some hysteresis exists in the adjustments. This prevents amplitude chatter when programming frequencies around the frequency limits.

4.2.4.2 855T ADJUSTMENT

The adjustment for the 855T is accomplished in the same manner as that for the 850T described in 4.2.4.1 except that the upper and lower limits must be set with the DIP switches mounted on the main board (A1). Figure 4-2 shows the location of the DIP switches. Table 4-1 lists the switch closures necessary to program 45, 60, 400 and 5000 Hz. If it is desired to program other frequencies, contact California Instruments' Customer Service Department for assistance.

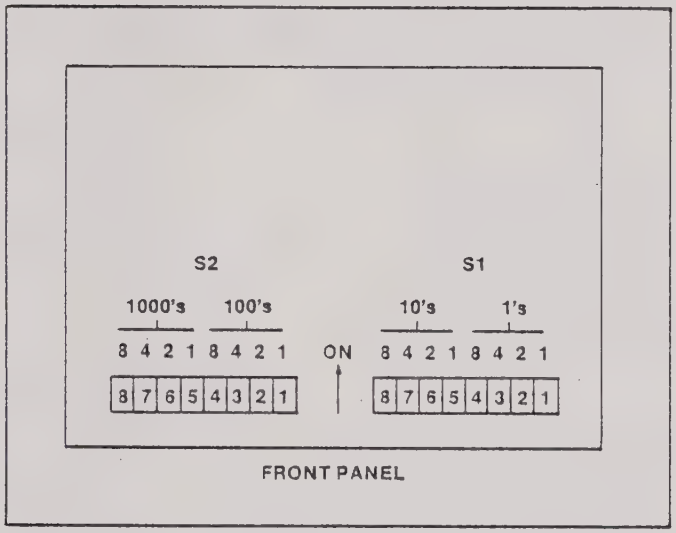


Figure 4-2. Location of Frequency Programming DIP Switches, Model 855T.

Table 4-1. Model 855T Frequency Programming.

	S2								S1							
	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
45 Hz	X	X	X	X	X	X	X	X	X	-	X	X	X	-	X	-
60 Hz	X	X	X	X	X	X	X	X	X	-	-	X	X	X	X	X
400 Hz	X	X	X	X	X	-	X	X	X	X	X	X	X	X	X	X
5000 Hz	X	-	X	-	X	X	X	X	X	X	X	X	X	X	X	X

- = OFF
X = ON

SECTION V—MAINTENANCE

5.1 GENERAL

This section of the manual contains information to assist in troubleshooting the Models 850T and 855T Precision Oscillators. A table of power supply voltages and "logic tree" types of troubleshooting charts are included. A review of the Theory of Operation in Section III is recommended prior to attempting to troubleshoot either unit. The technician will then have a good understanding of the circuit operation which will further assist in the troubleshooting task.

5.2 REQUIRED TEST EQUIPMENT

The test equipment required to perform the tests outlined in this section is listed in Table 5-1.

Table 5-1. Required Test Equipment.

California Instruments Model DMM-53 Digital Multimeter.
Frequency Counter with 20 MHz capability.
Calibrated Oscilloscope with 20 MHz, or better, response.

5.3.1 POWER SUPPLY TEST

Reduce the output of the oscillator to zero and measure the +15 volt, −15 volt and +5 volt supply lines. Verify that they are within the limits shown in Table 5-2.

If the power supply voltages are within limits, proceed to the next paragraph. If they are not, troubleshoot and repair the defective power supply.

5.3.2 CLOCK GENERATOR TEST

Check the clock generator signal with the oscilloscope at A1U13, pin 2. The clock signal should be a square wave with an amplitude of 3 volts, or more, peak-to-peak. If there is no clock signal, refer to the clock generator troubleshooting chart of Figure 5-1. If the clock signal is present, but the oscillator output is absent or severely distorted, refer to the waveform synthesizer troubleshooting chart of Figure 5-2.

Table 5-2. Power Supply Voltage Limits.

LINE	TEST POINT	LIMITS
+15V	TP3	+14.6 to +16.2 VDC
−15V	TP2	−14.6 to −16.2 VDC
+5V		+4.75 to +5.25 VDC

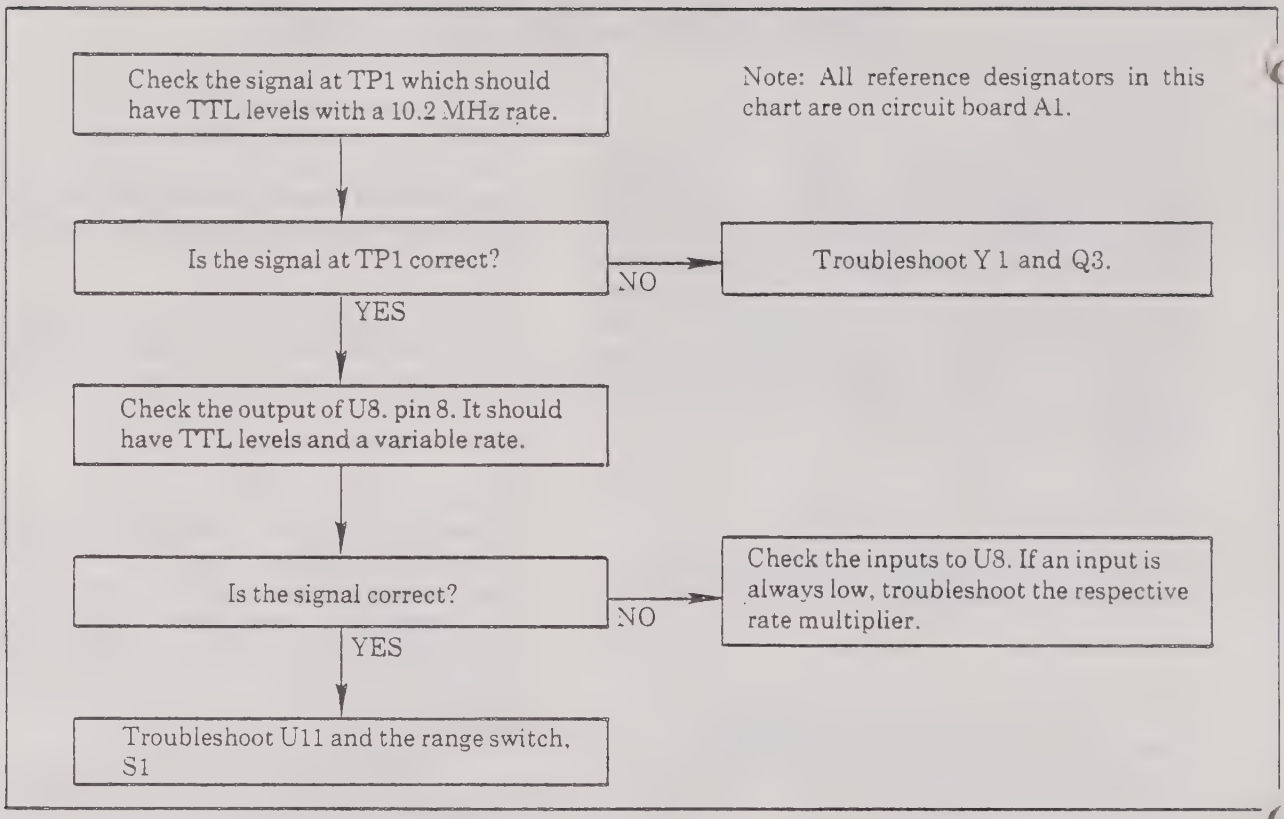

Check the signal at TP1 which should have TTL levels with a 10.2 MHz rate.
Note: All reference designators in this chart are on circuit board A1.
Is the signal at TP1 correct?
NO
Troubleshoot Y 1 and Q3.
YES
Check the output of U8. pin 8. It should have TTL levels and a variable rate.
Is the signal correct?
NO
Check the inputs to U8. If an input is always low, troubleshoot the respective rate multiplier.
YES
Troubleshoot U11 and the range switch, S1

Figure 5-1. Troubleshooting Chart, Clock Generator.

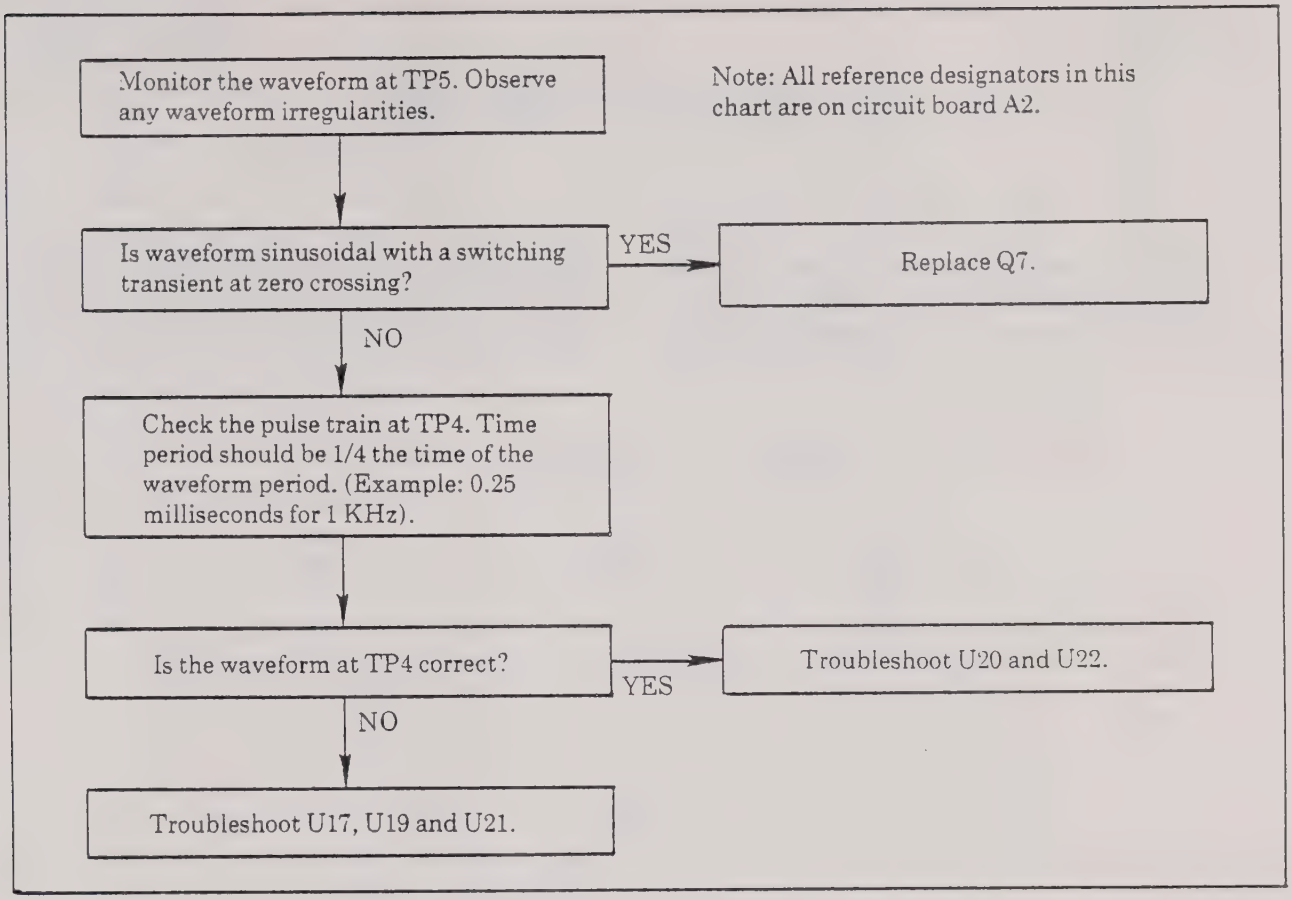

Monitor the waveform at TP5. Observe any waveform irregularities.
Note: All reference designators in this chart are on circuit board A2.
Is waveform sinusoidal with a switching transient at zero crossing?
YES
Replace Q7.
NO
Check the pulse train at TP4. Time period should be 1/4 the time of the waveform period. (Example: 0.25 milliseconds for 1 KHz).
Is the waveform at TP4 correct?
YES
Troubleshoot U20 and U22.
NO
Troubleshoot U17, U19 and U21.

Figure 5-2. Troubleshooting Chart, Waveform Synthesizer.

SECTION VI—DIAGRAMS

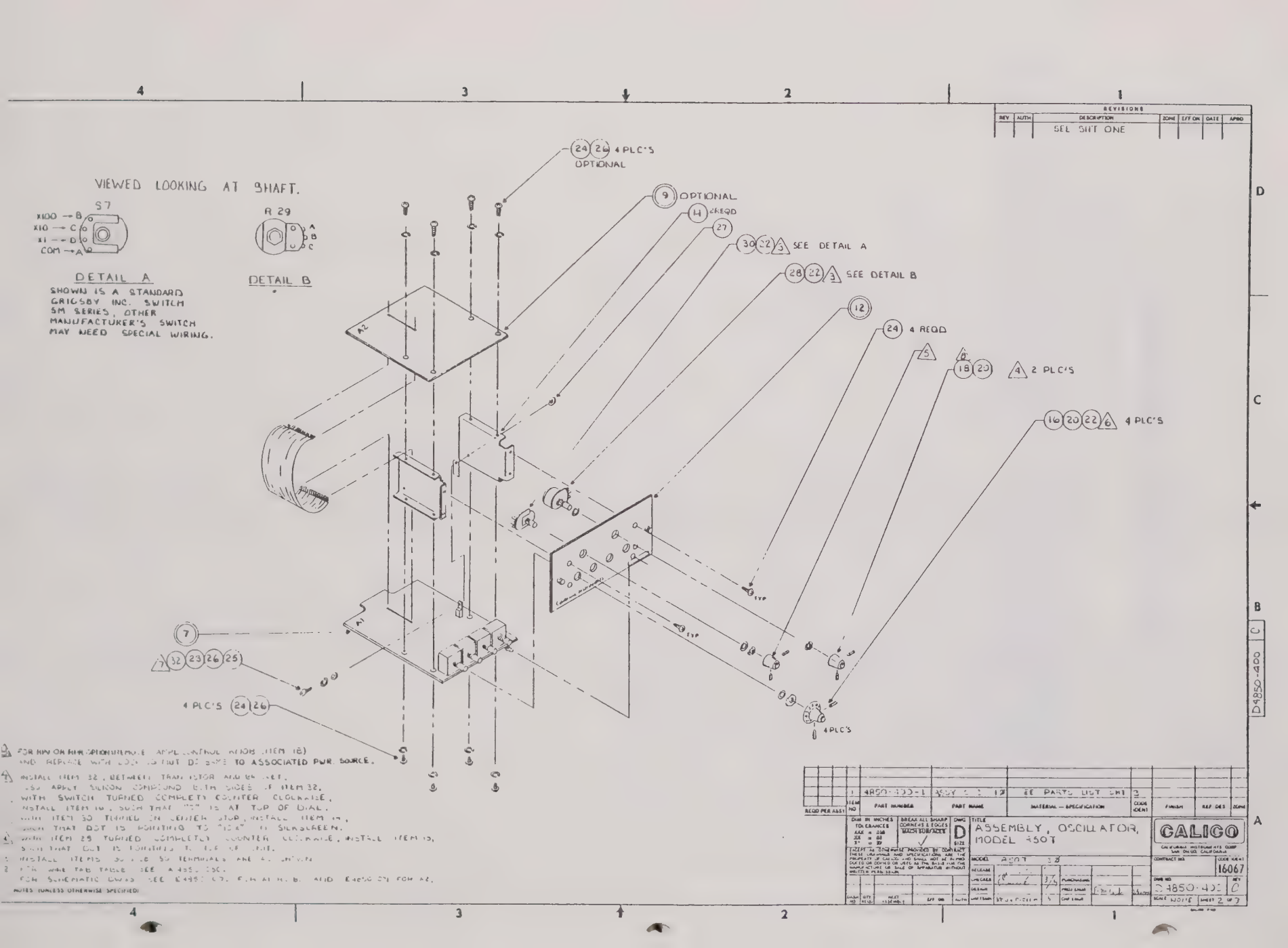
6.1 GENERAL

This section of the manual contains schematic and mechanical diagrams necessary for the operation and maintenance of the 850T/855T Series Precision Oscillators. The schematic diagrams illustrate the circuits while the mechanical assembly drawings indicate the component locations.

6-3 REFERENCE DESIGNATIONS

6-4 Partial reference designators are shown on schematic and mechanical drawings. Prefix these reference designators with assembly and/or sub-assembly designation for the complete reference designator. For example:

Assembly/Sub-Assembly	Component	Component Designation
None	T1	T1
A1	IC6	A1IC6
A2	R44	A2R44
A3	C7	A3C7
A4	Q2	A4Q2


VIEWED LOOKING AT SHAFT.
S7
X100 → B
X10 → C
X1 → D
COM → A
R 29
A
B
C
DETAIL A
SHOWN IS A STANDARD GRIGSBY INC. SWITCH SM SERIES. OTHER MANUFACTURER'S SWITCH MAY NEED SPECIAL WIRING.
DETAIL B
24 26 4 PLC'S OPTIONAL
9 OPTIONAL
11 2 REQD
27
30 22 3 SEE DETAIL A
28 22 3 SEE DETAIL B
12
24 4 REQD
5
18 20 4 2 PLC'S
16 20 22 6 4 PLC'S
7
32 23 26 25
4 PLC'S 24 26
4 PLC'S
A2
A1
D4850-400
REVISIONS
REV AUTH DESCRIPTION ZONE EFF ON DATE APRD
SEE SHT ONE
1 4850-333-1 ASSY 2 2 12 SEE PARTS LIST SHT 3
REQD PER ASSY ITEM NO PART NUMBER PART NAME MATERIAL — SPECIFICATION CODE IDENT FINISH REF DES ZONE
DIMS IN INCHES TOLERANCES XXX = .010 XX = .02 X = .1 BREAK ALL SHARP CORNERS & EDGES MACH SURFACES
DWG SIZE D
TITLE ASSEMBLY, OSCILLATOR, MODEL 450T
CALICO
MODEL 450T S8
CONTRACT NO. CODE IDENT 16067
DWG NO 4850-400 REV C
SCALE NONE SHEET 2 OF 3
NOTES (UNLESS OTHERWISE SPECIFIED)
4 FOR MFG OR INSPECTION REMOVE APPLICATION NOTE (ITEM 18) AND REPLACE WITH LOCK WASHER TO BE SAME AS ASSOCIATED PUR SOURCE.
5 INSTALL ITEM 32, BETWEEN TRANSISTOR AND HEAT SINK. USE APPLY SILICON COMPOUND BOTH SIDES OF ITEM 32.
6 WITH SWITCH TURNED COMPLETELY COUNTER CLOCKWISE, INSTALL ITEM 18, SUCH THAT "10" IS AT TOP OF DIAL.
WITH ITEM 30 TURNED IN CENTER STOP, INSTALL ITEM 19, SUCH THAT DOT IS POINTING TO "10" ON SILKSCREEN.
WITH ITEM 29 TURNED COMPLETELY COUNTER CLOCKWISE, INSTALL ITEM 13, SUCH THAT DOT IS POINTING TO 1.0 OF DIAL.
7 INSTALL ITEMS 30 & 1.0 SO TERMINALS ARE AS SHOWN
2 PER WIRE TAB TABLE SEE A 485 . DSC.
FOR SCHEMATIC DWGS SEE E 485 - 0?. FOR A1 PC. BD. AND E 485 0? FOR A2.

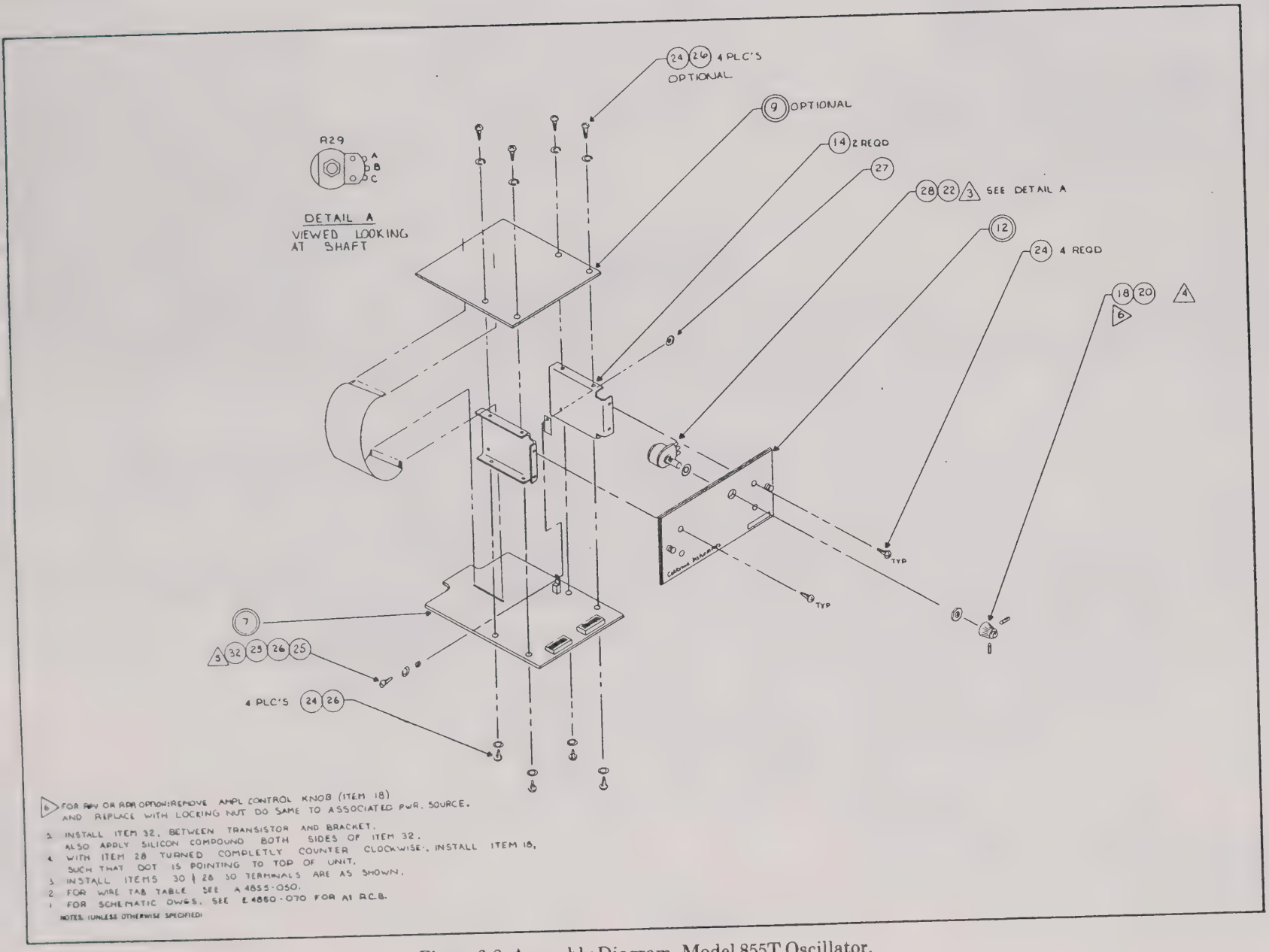
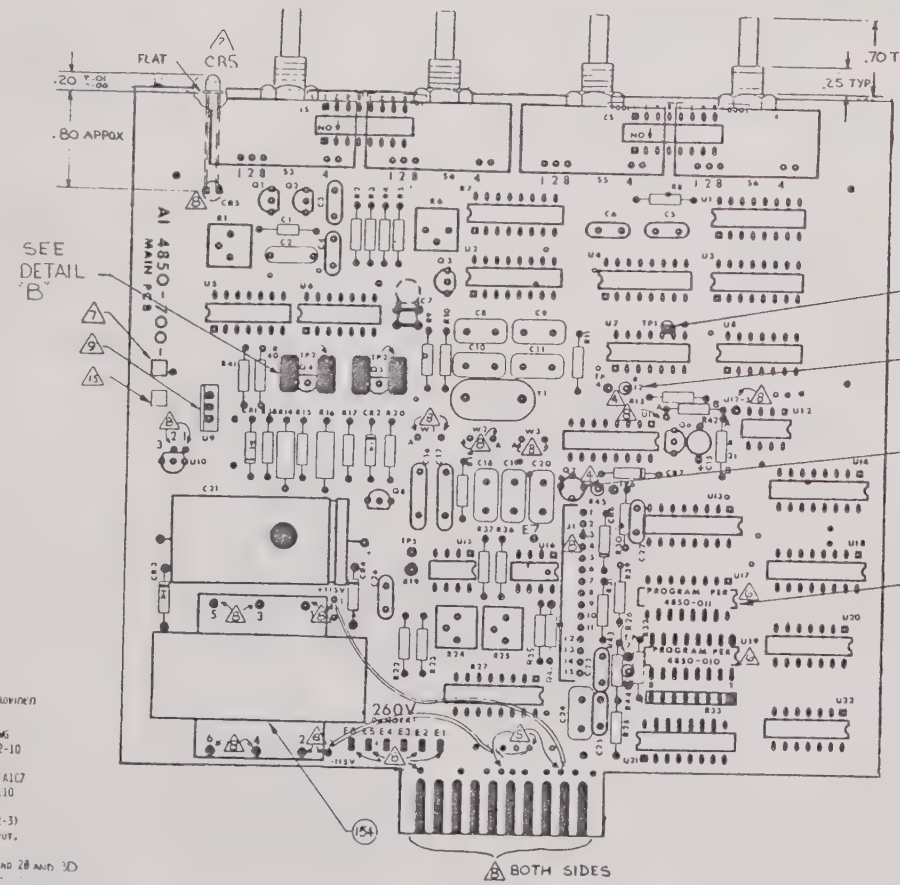

24 26 4 PLC'S OPTIONAL
9 OPTIONAL
14 2 REQD
27
28 22 3 SEE DETAIL A
12
24 4 REQD
18 20 4
6
R29
A
B
C
DETAIL A
VIEWED LOOKING AT SHAFT
TYP
TYP
7
3 32 23 26 25
4 PLC'S 24 26
6 FOR R&V OR R&R OPTION: REMOVE AMPL CONTROL KNOB (ITEM 18) AND REPLACE WITH LOCKING NUT DO SAME TO ASSOCIATED PWR. SOURCE.
5. INSTALL ITEM 32, BETWEEN TRANSISTOR AND BRACKET. ALSO APPLY SILICON COMPOUND BOTH SIDES OF ITEM 32.
4. WITH ITEM 28 TURNED COMPLETLY COUNTER CLOCKWISE', INSTALL ITEM 18, SUCH THAT DOT IS POINTING TO TOP OF UNIT.
3. INSTALL ITEMS 30 & 28 SO TERMINALS ARE AS SHOWN.
2. FOR WIRE TAB TABLE SEE A 4855-050.
1. FOR SCHEMATIC DWGS. SEE E 4850-070 FOR A1 P.C.B.
NOTES: (UNLESS OTHERWISE SPECIFIED)

Figure 6-2. Assembly Diagram, Model 855T Oscillator.

READ ALL NOTES BEFORE ASSEMBLY



(115) SEE DETAIL C
TP1, TP2, TP6

4 SEE DETAIL A
R12, R19, R26, R44, R45

(152) INSTALL UNDER Q7

(150) INSTALL UNDER U17/U19

DETAIL C
TP1, TP2, TP3

.25 MAX
DETAIL B
Q4, Q5

.20 R APPOX 4
DETAIL A
R12, R19, R26, R44, R45

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	ECP ON	DATE	APRD
		SEE SHT ONE				

4 PERMANENTLY MARK LATEST ASSY. REV. LTR IN SPACE PROVIDED

14. FOR OPTION RPV: SEE E.R.A., ASSEMBLY DRAWING D4850-400. ADD 24 AWG RED JUMPER FROM A1U10-1 TO A1E5. ADD 24 AWG BLACK JUMPER FROM A1J2-10 TO A1R29-A. SEE W.T.T.
13. FOR OPTION "A": THIS CREATES AN .0001% ACCURACY ON A1 P.C.B. ADD A1C7 (CALICO 66-10909), DELETE A1C10 (CALICO 66-10003), REPLACE WITH A1C10 CALICO 66-11072. SEE E.R.A. AND TEST PROCEDURE.
12. FOR OPTIONAL 260V SERVO OUTPUTS: A2 P.C.B. (4850-702-2 OR 4850-702-3) IS USED. SEE SCHEMATIC 4850-078. SEE ALSO E.R.A. TO CONVERT OUTPUT, SEE W.T.T.
11. FOR SQUARE WAVE OPTION: OSCILLATOR CAPABILITY EXTENDS ONLY TO 1B AND 2B AND 3D PHASE UNITS. SEE [illegible] ADD [illegible] 4850-7 [illegible] AND 4850-7 [illegible]
10. FOR RESISTANCE PROGRAMMING: IF 2B OR 3B OUTPUTS ARE NEEDED, USE A2 P.C.B. 4850-702-11. SEE SCHEMATIC E4850-078 FOR CHANGES TO A2 P.C.B. [illegible]
9. SOLDER U9 IN PLACE, AFTER SIDE BRACKET IS IN PLACE.
8. CLAD PADS MUST BE MASKED BEFORE WAVE SOLDER.
7. WHEN ASSEMBLING P.C.B. MARK DASH NUMBER (-1, -2, -3, ETC.) IN BLOCK PROVIDED
6. P.C.'s U17 AND U19 MUST BE PROGRAMMED PER SEC. 4850-011 FOR U17 AND 4850-010 FOR U19
5. WIRE TAB TABLE (W.T.T.) IS 4850-050 FOR 850T AND 4855-050 FOR 855T/853T.
4. INSTALL ITEMS R12, R19, R26 AS SHOWN IN DETAIL "A".
3. NOTE THAT THIS ASSEMBLY SHOWN LOCATIONS FOR ALL POSSIBLE COMPONENTS SEE PARTS LIST FOR COMPONENTS NOT USED IN SPECIFIC ASSEMBLIES.
2. INSTALL CR5, AS SHOWN, AFTER WAVE SOLDER.
1. FOR SCHEMATIC, SEE DRAWING E4850-070.

NOTES: (UNLESS OTHERWISE SPECIFIED)

	RPV	SEE ERA	NOTE 14
	"A"	.0001% ACCURACY	NOTE 13
4850-		SQUARE WAVE	NOTE 11
4850-	RPR	RESISTANCE PROGR.	NOTE 10
4850-700-3		STD 853T SEE ERA	
4850-700-2		STD 855T SEE P.L.	
4850-700-1		STD 850T SEE P.L.	

ASSEMBLY NO.	OPTION	FUNCTION / NOTE REF
SEE SPECIFIC PARTS LIST OR ERA FOR EACH OPTION		

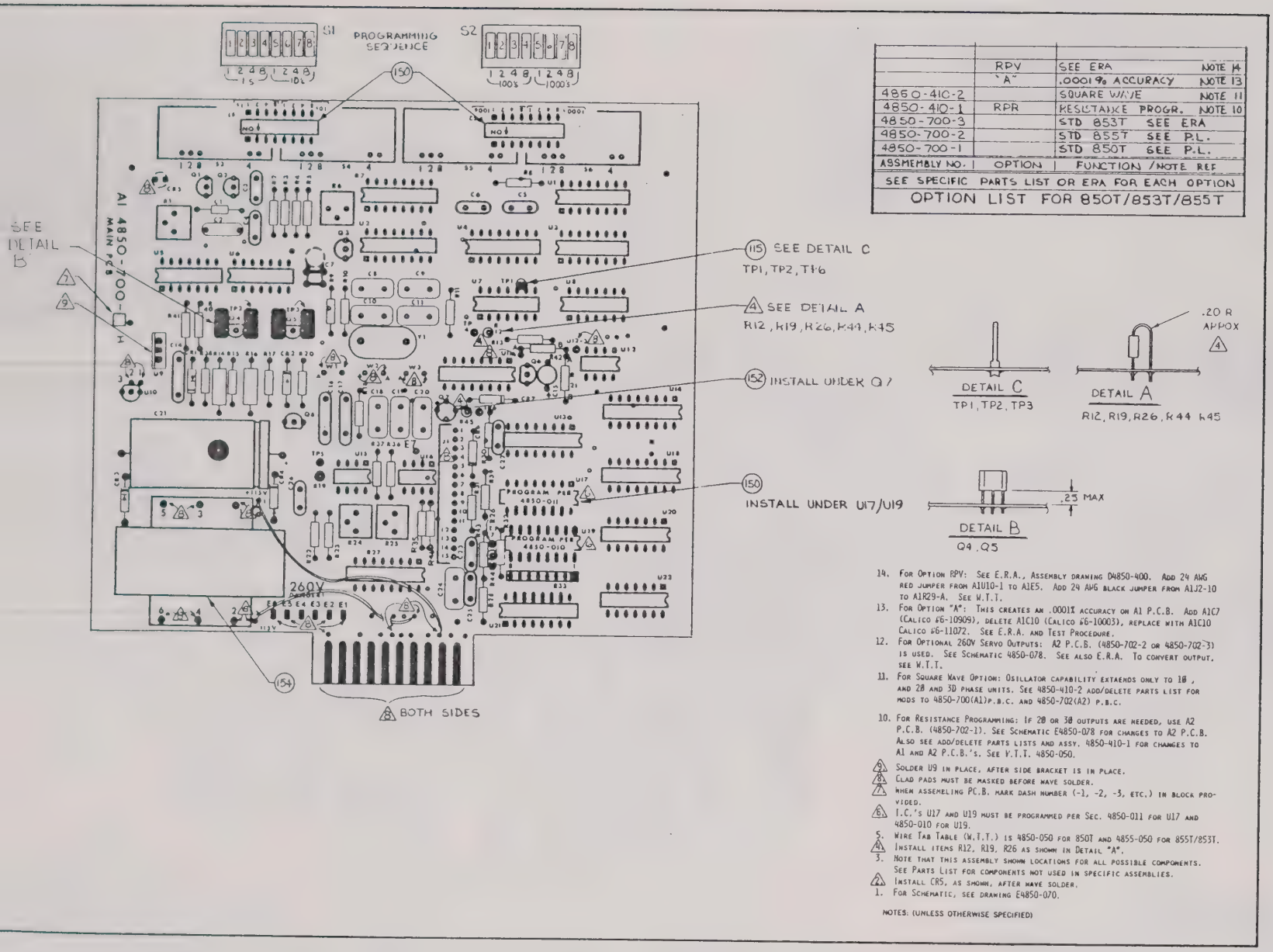
OPTION LIST FOR 850T/853T/855T

ITEM NO	REQD PER ASSY	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES	ZONE
5								
4								
3	X	4850-700-3	853T	SEE SHTS 4-9				
2	X	4850-700-2	855T	SEE SHTS 4-9				
1	X	4850-700-1	850T	SEE SHTS 4-9				

DIM IN INCHES TOLERANCES XXX ± .010, XX ± .01, X° ± 10'
BREAK ALL SHARP CORNERS & EDGES EXCEPT AS SPECIFIED
DWG SIZE D
TITLE: MAIN P.C BOARD ASSEMBLY A1
CALICO — CALICO INSTRUMENTS CORP SAN DIEGO, CALIFORNIA
MODEL 851T
CONTRACT NO
CODE IDENT 16067
RELEASE
CHECKED
PURCHASING
DESIGN
PROJ ENGR
DRAFTSMAN Robb 8/9/82
DWG NO D4850-700
SCALE 2/1
SHEET 2 OF 9

DASH NO	QTY REQ	REV LTR	ASSEMBLY	ECP ON	AUTH
-2	1		4855-400		
-1	1		4850-400		

D4850-700



	RPV	SEE ERA NOTE 14
	"A"	.0001% ACCURACY NOTE 13
4850-410-2		SQUARE WAVE NOTE 11
4850-410-1	RPR	RESISTANCE PROGR. NOTE 10
4850-700-3		STD 853T SEE ERA
4850-700-2		STD 855T SEE P.L.
4850-700-1		STD 850T SEE P.L.
ASSMEMBLY NO.	OPTION	FUNCTION / NOTE REF

SEE SPECIFIC PARTS LIST OR ERA FOR EACH OPTION

OPTION LIST FOR 850T/853T/855T

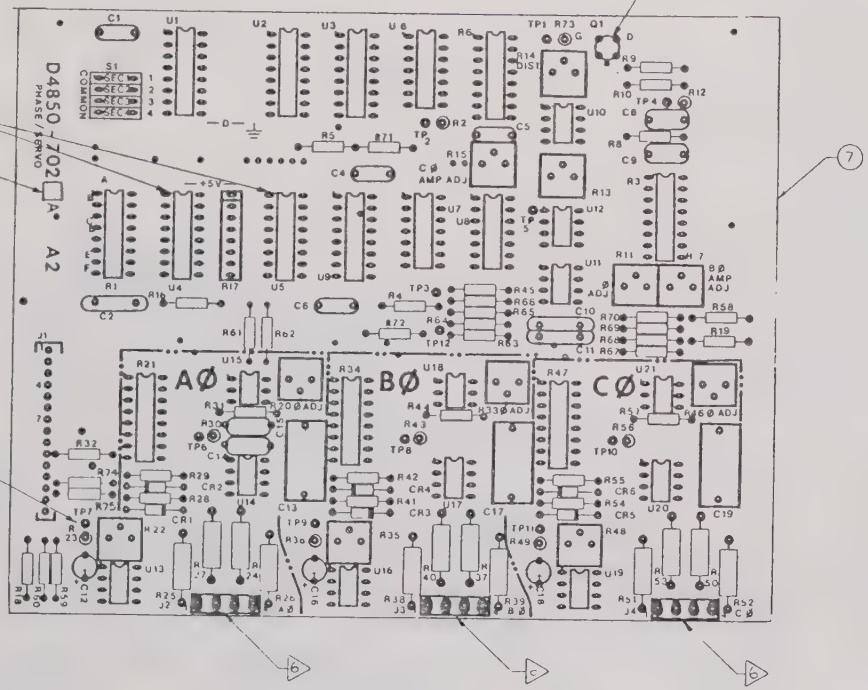
14. For Option RPV: See E.R.A., Assembly drawing D4850-400. Add 24 AWG red jumper from A1U10-1 to A1E5. Add 24 AWG black jumper from A1J2-10 to A1R29-A. See W.T.T.
13. For Option "A": This creates an .0001% accuracy on A1 P.C.B. Add A1C7 (Calico #6-10909), delete A1C10 (Calico #6-10003), replace with A1C10 Calico #6-11072. See E.R.A. and Test Procedure.
12. For Optional 260V Servo Outputs: A2 P.C.B. (4850-702-2 or 4850-702-3) is used. See Schematic 4850-078. See also E.R.A. To convert output, see W.T.T.
11. For Square Wave Option: Osillator capability extaends only to 1Ø, and 2Ø and 3Ø phase units. See 4850-410-2 add/delete parts list for mods to 4850-700(A1)P.B.C. and 4850-702(A2) P.B.C.
10. For Resistance Programming: If 2Ø or 3Ø outputs are needed, use A2 P.C.B. (4850-702-1). See Schematic E4850-078 for changes to A2 P.C.B. Also see add/delete parts lists and assy. 4850-410-1 for changes to A1 and A2 P.C.B.'s. See W.T.T. 4850-050.

9. Solder U9 in place, after side bracket is in place.
8. Clad pads must be masked before wave solder.
7. When assemeling P.C.B. mark dash number (-1, -2, -3, etc.) in block provided.
6. I.C.'s U17 and U19 must be programmed per Sec. 4850-011 for U17 and 4850-010 for U19.
5. Wire Tab Table (W.T.T.) is 4850-050 for 850T and 4855-050 for 855T/853T.
4. Install items R12, R19, R26 as shown in Detail "A".
3. Note that this assembly shown locations for all possible components. See Parts List for components not used in specific assemblies.
2. Install CR5, as shown, after wave solder.
1. For Schematic, see drawing E4850-070.

NOTES: (UNLESS OTHERWISE SPECIFIED)

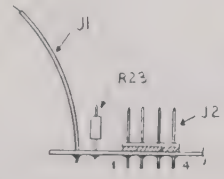
Figure 6-5. Assembly Diagram, Model 855T Main Board, A1.

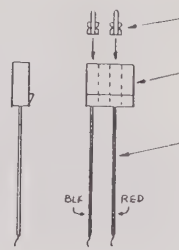
REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD
		SEE SHEET ONE				



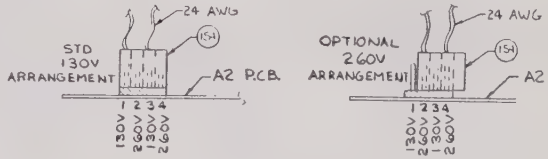
APPROX. .25 R BEND

2 DETAIL A-A





NOTE: STD OSC. IS WIRED FOR 130V SERVO OUTPUT TO CONVERT TO 260V SERVO OUTPUT DO AS ILLUSTRATED:



COMPONENT SIDE SHOWN

FOR SQUARE WAVE : REMOVE C9, C8, U4 AND U5. SEE 4850-410-2 ADD/DEL PARTS LIST.

FOR RESISTANCE PROGRAMMING : REMOVE R4 AND R5. ADD R71 AND R72. SEE 4850-410-1 ADD/DEL PARTS LIST.

WHEN P.C.B. IS ASSEMBLED MARK DASH NO. (-1,-2 OR -3) OF ASSEMBLY IN THIS BOX.

THIS ASSY DWG SHOWS ALL THE POSSIBLE COMPONENTS IN THE P.C.B., SEE PARTS LIST FOR THOSE COMPONENTS NOT USED.

CAUTION, Q1 IS SUPPLIED WITH A RUBBER BAND AROUND IT'S LEGS. THIS BAND MUST BE LEFT IN PLACE UNTIL AFTER SOLDERING. AFTER SOLDERING BAND MUST BE CUT AND REMOVED. INSTALL SOCKET UNDER R1.

INSTALL J1, J2, J3, AND J4 BEFORE WAVE SOLDER.

PROGRAM U4 PER SPEC. 4850-011.

PROGRAM U5 PER SPEC. 4850-010.

INSTALL I.C. SOCKETS UNDER U4 & U5.

INSTALL R73, R2, R12, R23, R30, R36, R43, R49, AND R56. AS SHOWN IN DETAIL A-A.

GR SCHEMATIC DWG SEE E4850-078.

ES (UNLESS OTHERWISE SPECIFIED)

REQD PER ASSY	ITEM NO	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES	ZONE
X	3	4850-410-3	P.C.B. ASSY	SEE SHEET 3 & 4				
X	2	4850-410-2	P.C.B. ASSY	SEE SHEETS 4-8				
X	1	4850-410-1	PHASE P.C.	SEE SHEETS 4-8				

DIM IN INCHES TOLERANCES XXX - .010 XX - .03 X - .1 | BREAK ALL SHARP CORNERS & EDGES MACH SURFACES ✓ | DWG SIZE D

TITLE ASSEMBLY PHASE / SERVO P.C.B. A2

MODEL 850T / 855T / 853T

CALICO — CALIFORNIA INSTRUMENTS CORP SAN DIEGO, CALIFORNIA

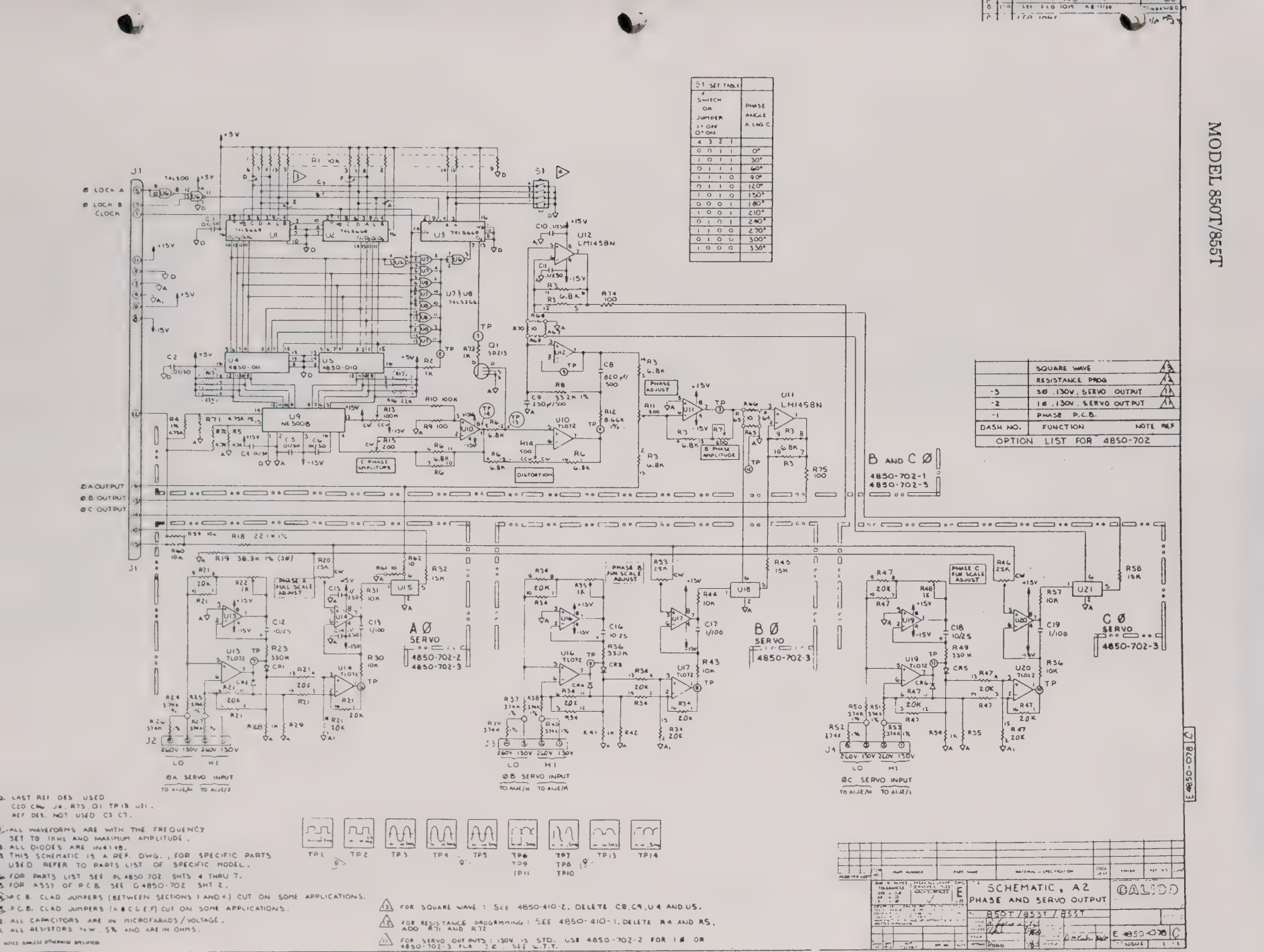
CONTRACT NO. | CODE IDENT 16067

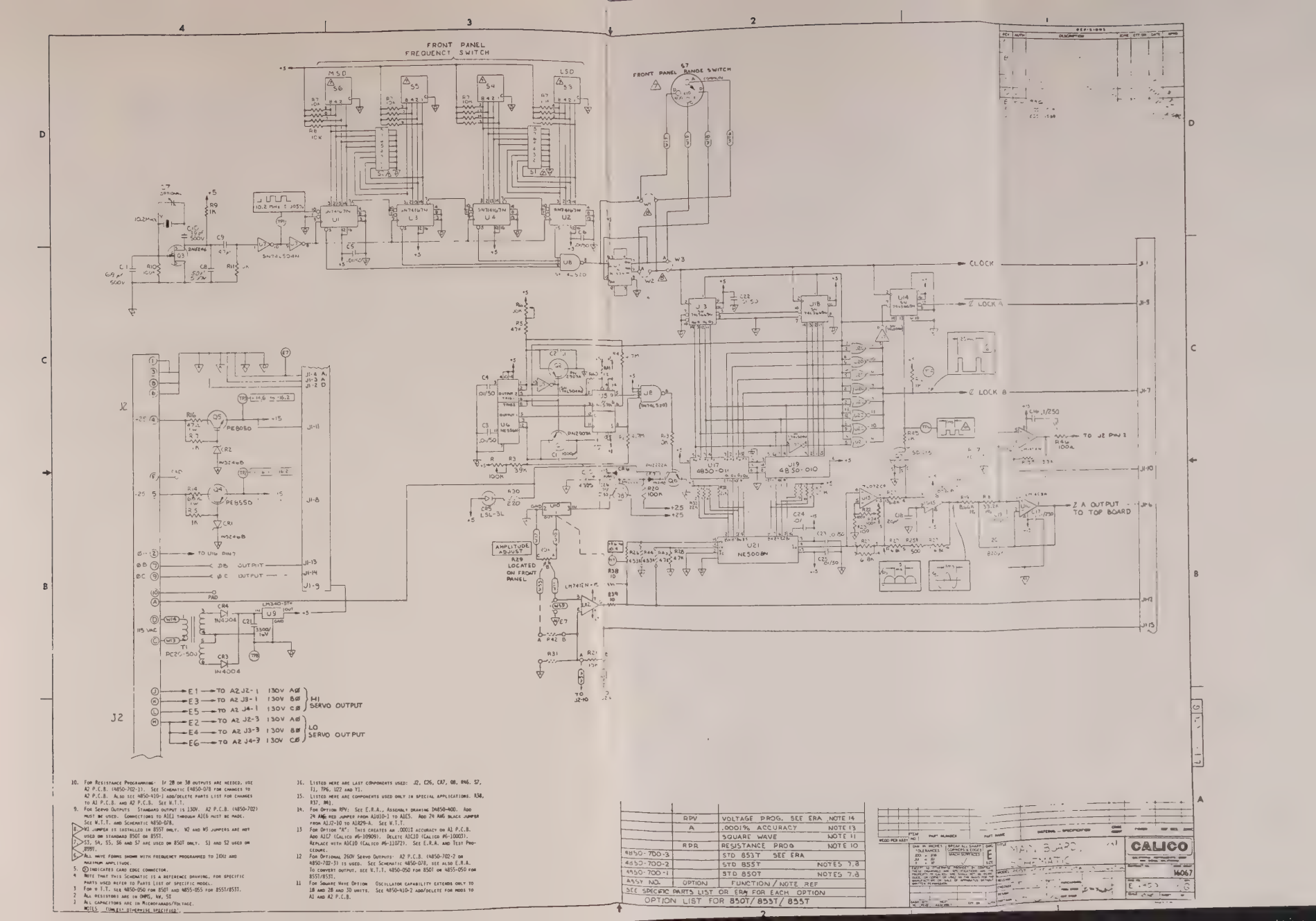
DWG NO D4850-702 | REV A

SCALE 2/1 | SHEET 2 OF 8

	DATE	
CHECKED		
DESIGN	8-7-74	
DRFTSMN	8-7-74	
PURCHASING		
PROJ ENGR		
CHF ENGR		

D4850-702 A


MODEL 850T/855T
S1 SET TABLE
SWITCH OR JUMPER 1= OFF 0= ON
PHASE ANGLE A LAG C
4 3 2 1
0 0 1 1 0°
1 0 1 1 30°
0 1 1 1 60°
1 1 1 0 90°
0 1 1 0 120°
1 0 1 0 150°
0 0 0 1 180°
1 0 0 1 210°
0 1 0 1 240°
1 1 0 0 270°
0 1 0 0 300°
1 0 0 0 330°
SQUARE WAVE
RESISTANCE PROG
-3 3Ø, 130V, SERVO OUTPUT
-2 1Ø, 130V, SERVO OUTPUT
-1 PHASE P.C.B.
DASH NO. FUNCTION NOTE REF
OPTION LIST FOR 4850-702
B AND C Ø
4850-702-1
4850-702-3
A Ø SERVO
4850-702-2
4850-702-3
B Ø SERVO
4850-702-3
C Ø SERVO
4850-702-3
ØA SERVO INPUT
ØB SERVO INPUT
ØC SERVO INPUT
TP1 TP2 TP3 TP4 TP5 TP6 TP9 TP11 TP7 TP8 TP10 TP13 TP14
SCHEMATIC, A2 PHASE AND SERVO OUTPUT
850T/855T/855T
GALILEO
E 4850-702 C



10. For Resistance Programming: If 2Ø or 3Ø outputs are needed, use A2 P.C.B. (4850-702-13). See Schematic E4850-078 for changes to A2 P.C.B. Also see 4850-410-1 add/delete parts list for changes to A1 P.C.B. and A2 P.C.B. See W.I.T.
9. For Servo Outputs: Standard output is 130V. A2 P.C.B. (4850-702) must be used. Connections to A1E1 through A1E6 must be made. See W.I.T. and Schematic 4850-078.
8. W1 jumper is installed in 855T only. W2 and W3 jumpers are not used on standard 850T or 855T.
7. S3, S4, S5, S6 and S7 are used on 850T only. S1 and S2 used on 855T.
6. All wave forms shown with frequency programmed to 1KHz and maximum amplitude.
5. ⓟ indicates card edge connector.
4. Note that this Schematic is a reference drawing, for specific parts used refer to Parts List of specific model.
3. For W.I.T. see 4850-050 for 850T and 4855-055 for 855T/855T.
2. All resistors are in OHMS, kW, ST
1. All capacitors are in Microfarads/Voltage.
NOTES: UNLESS OTHERWISE SPECIFIED:

16. Listed here are last components used: J2, C26, C27, Q8, Ø46, S7, T1, TP6, U22 and Y1.
15. Listed here are components used only in special applications. R38, R37, W1.
14. For Option RPV: See E.R.A., Assembly Drawing D4850-400. Add 24 AWG red jumper from A1Ø10-1 to A1E5. Add 24 AWG black jumper from A1J2-10 to A1P29-A. See W.I.T.
13. For Option "A": This creates an .ØØØ1% accuracy on A1 P.C.B. Add A1C7 (Calico #6-10909). Delete A1C10 (Calico #6-10003). Replace with A1C10 (Calico #6-11072). See E.R.A. and Test Procedure.
12. For Optional 260V Servo Outputs: A2 P.C.B. (4850-702-2 or 4850-702-31 is used. See Schematic 4850-078. See also E.R.A. To convert output, see W.I.T. 4850-050 for 850T or 4855-050 for 855T/855T.
11. For Square Wave Option: Oscillator capability extends only to 1B and 2B and 3D units. See 4850-410-2 add/delete for mods to A1 and A2 P.C.B.

	RPV	VOLTAGE PROG. SEE ERA	NOTE 14
	A	.ØØØ1% ACCURACY	NOTE 13
		SQUARE WAVE	NOTE 11
	RPR	RESISTANCE PROG	NOTE 10
4850-700-3		STD 855T SEE ERA	
4850-700-2		STD 855T	NOTES 7,8
4850-700-1		STD 850T	NOTES 7,8
ASSY NO.	OPTION	FUNCTION / NOTE REF	

SEE SPECIFIC PARTS LIST OR ERA FOR EACH OPTION

OPTION LIST FOR 850T/855T/855T

CALICO

16067

E-953

SECTION VII
REPLACEABLE PARTS LISTS

7-1 GENERAL

7-2 This section of the manual contains ordering information and complete lists of replaceable parts. Parts are listed by major assembly in alpha-numerical order of their reference designators. Description, manufacturer's code ident number and CALIFORNIA INSTRUMENTS DIVISION stock numbers are indicated. A list of manufacturers and their Federal Supply Codes will be found in Appendix A.

7-3 ORDERING INFORMATION

7-4 That we may process your order promptly, please provide the following information, when applicable:

A) Model and serial numbers of the instrument.

B) CALIFORNIA INSTRUMENTS DIVISION part number of the sub-assembly where the component is located.

C) Component reference designator

D) Component Description.

E) Component manufacturer's number and code indentification

F) CALIFORNIA INSTRUMENTS DIVISION stock number.

7-5 All replacement parts orders should be placed with AIKEN INDUSTRIES, CALIFORNIA INSTRUMENTS DIVISION, 5150 Convoy Street, San Diego, Calif. 92111.

California Instruments

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
	4850-400-1	850T, 1 PHASE	16067		1
					2
					3
					4
					5
					6
A1	4850-700-1	P.C.B. ASSY, MAIN A1	16067		7
					8
					9
					10
					11
	C4850-200-1	FRONT PANEL	16067	1-10698	12
					13
	C4850-201-1	SIDE BRACKET	16067	1-10699	14
					15
	PS-70TSL-2-BLK	KNOB, W/CLEAR SKIRT	21604	2-10650	16
					17
	PS-70D-2-BLK	KNOB, W/DOT. BLK	21604	2-10191	18
					19
		NUT, ½ HEX, 3/8-32	81349	2-10187	20
					21
	5/16I.D. .02THK	WASHER ½ O.D.			22
	4-40 x 3/8 Lg.	SCREW. MACH. PAN HD	81349		23
	4-40x3/8PHP.PAN	SCREW, SELF CUTTING TYPE"D"			24
	NY04-040	SHOULDER WASHER	08289	2-10076	25
	#4	WASHER SPLIT LOCK			26
	#4-40	HEX NUT			27
R29	B4010-012-1	POTENTIOMETER, 10K	16067	5-70128	28
					29
S7	47862 5M REV A	SWITCH, 3 POS.	82104	2-40478	30
					31
	4673	MICA, WASHER	91833	2-10474	32
		SILICON COMPOUND			33
					34
					35
					36

MODEL 850T ALL PHASES | CALICO P/N 4850-400 | ASSY R.D.

TITLE OSCILLATOR, PROGRAMMABLE | SHT OF

California Instruments	CODE IDENT 16067	PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A1	4850-700-1	P.C.B. ASSY. 850T			1
A1	4850-700-2	P.C.B. ASSY. 855T			2
A1	4850-700-3	P.C.B. ASSY. 853T			3
					4
					5
					6
	D4850-700-7	P.C.B. MECH.	16067	1-60306	7
					8
					9
A1C1	C22A102K	CAPACITOR 1000PF 100V	71590	6-11060	10
A1C2	C280AE/A100K	CAPACITOR .1μF 250V	73445	6-10916	11
A1C3	CK-103	CAPACITOR .01μF 50V	71590	6-10094	12
A1C4	CK-103	CAPACITOR .01μF 50V	71590	6-10094	13
A1C5	CK-103	CAPACITOR .01μF 50V	71590	6-10094	14
A1C6	CK-103	CAPACITOR .01μF 50V	71590	6-10094	15
A1C7	NOT USED				16
A1C8	DM-15-500J	CAPACITOR 50PF 500V	72136	6-10015	17
A1C9	CM05E470J03	CAPACITOR 47PF 500V	81349	6-10268	18
A1C10	CM05E390J03	CAPACITOR 39PF 500V	81349	6-10013	19
A1C11	CM05E680J03	CAPACITOR 68PF 500V	81349	6-11071	20
A1C12	NOT USED				21
A1C13	NOT USED				22
A1C14	NOT USED				23
A1C15	T362B475M025AS	CAPACITOR 4.7μF 25V	05397	6-10802	24
A1C16	C280AE/A100K	CAPACITOR .1μF 250V	73445	6-10916	25
A1C17	C280AE/A100K	CAPACITOR .1μF 250V	73445	6-10916	26
A1C18	NOT USED				27
A1C19	CM05F251J03	CAPACITOR 250PF 500V	02799	6-10620	28
A1C20	CM05F821J03	CAPACITOR 820PF 500V	02799	6-10050	29
A1C21	TDA3300M16T	CAPACITOR 3300μF 16V	30039	6-11056	30
A1C22	CK-103	CAPACITOR .01μF 50V	71590	6-10094	31
A1C23	CK-103	CAPACITOR .01μF 50V	71590	6-10094	32
A1C24	CK-103	CAPACITOR .01μF 50V	71590	6-10094	33
A1C25	CK-103	CAPACITOR .01μF 50V	71590	6-10094	34
A1C26	CK-103	CAPACITOR .01μF 50V	71590	6-10094	35
					36

MODEL 850T/855T/853T	CALICO P/N 4850-700	ASSY R.D.
TITLE MAIN P.C.B. ASSEMBLY	SHT 5 OF 8	A1

California Instruments

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
					37
					38
A1CR1	1N5246B	DIODE, ZENER	04713	3-10173	39
A1CR2	1N5246B	DIODE, ZENER	04713	3-10173	40
A1CR3	1N4004	RECTIFIER	04713	3-10062	41
A1CR4	1N4004	RECTIFIER	04713	3-10062	42
A1CR5	LSL-3L	INDICATOR, LED	0000S	2-50212	43
A1CR6	1N4148	DIODE	24503	3-10227	44
A1CR7	1N4148	DIODE	24503	3-10227	45
					46
					47
					48
A1R1	63P104	POTENTIOMETER 100K	02111	5-70265	49
A1R2	RC07GF475J	RESISTOR 4.7M ¼W 5%	81349	5-10130	50
A1R3	RC07GF393J	RESISTOR 39K ¼W 5%	81349	5-10090	51
A1R4	RC07GF475J	RESISTOR 4.7M ¼W 5%	81349	5-10130	52
A1R5	RC07GF473J	RESISTOR 47K ¼W 5%	81349	5-10092	53
A1R6	63P104	POTENTIOMETER 100K	02111	5-70265	54
A1R7	898-1-R10K	RESISTOR 10K DIP	73138	3-60241	55
A1R8	RC07GF103J	RESISTOR 10K ¼W 5%	81349	5-10076	56
A1R9	RC07GF102J	RESISTOR 1K ¼W 5%	81349	5-10053	57
A1R10	RC07GF104J	RESISTOR 100K ¼W 5%	81349	5-10100	58
A1R11	RC07GF103J	RESISTOR 10K ¼W 5%	81349	5-10076	59
A1R12	RC07GF102J	RESISTOR 1K ¼W 5%	81349	5-10053	60
A1R13	RC07GF103J	RESISTOR 10K ¼W 5%	81349	5-10076	61
A1R14	RC32GF680J	RESISTOR 68Ω 1W 5%	81349	5-30004	62
A1R15	RC07GF102J	RESISTOR 1K ¼W 5%	81349	5-10053	63
A1R16	RC32GF470J	RESISTOR 47Ω 1W 5%	81349	5-30068	64
A1R17	RC07GF102J	RESISTOR 1K ¼W 5%	81349	5-10053	65
A1R18	RN55D3322F	RESISTOR 33.2K 1%	81349	5-60575	66
A1R19	RN55D8661F	RESISTOR 8.66K 1%	81349	5-60747	67
A1R20	RC07GF104F	RESISTOR 100K ¼W 5%	81349	5-10100	68
A1R21	RC07GF103J	RESISTOR 10K ¼W 5%	81349	5-10076	69
A1R22	RC07GF104F	RESISTOR 100K ¼W 5%	81349	5-10100	70
A1R23	RC07GF101J	RESISTOR 100Ω ¼W 5%	81349	5-10029	71
					72

MODEL 850T/855T/853T

CALICO P/N 4850-700

ASSY R.D.

TITLE MAIN P.C.B. ASSEMBLY

California Instruments

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A1R24	63P104	POTENTIOMETER 100K	02111	5-70265	73
A1R25	63P501	POTENTIOMETER 500Ω	02111	5-70266	74
A1R26	RN55D4531F	RESISTOR 4.53K 1%	81349	5-60748	75
A1R27	698-3-6.8K-F	RESISTOR 6.8K PACK	73138	3-60232	76
A1R28	RC07GF472J	RESISTOR 4.7K ¼W 5%	81349	5-10068	77
A1R29	NOT USED				78
A1R30	RC07GF221J	RESISTOR 220Ω ¼W 5%	81349	5-10037	79
A1R31	NOT USED				80
A1R32	RC07GF223J	RESISTOR 22K ¼W 5%	81349	5-10084	81
A1R33	764-1-R22K	RESISTOR 22K SIP	73138	3-60154	82
A1R34	898-3-R22	RESISTOR ARRAY 22Ω	73138	3-60261	83
A1R35	RC07GF332J	RESISTOR 3.3K ¼W 5%	81349	5-10064	84
A1R36	RC07GF100J	RESISTOR 10Ω ¼W 5%	81349	5-10005	85
A1R37	NOT USED				86
A1R38	NOT USED				87
A1R39	RC07GF100J	RESISTOR 10Ω ¼W 5%	81349	5-10005	88
A1R40	RC07GF10IJ	RESISTOR 100Ω ¼W 5%	81349	5-10029	89
A1R41	NOT USED				90
A1R42	NOT USED				91
A1R43	NOT USED				92
A1R44	NOT USED				93
A1R45	RC07GF102J	RESISTOR 1K ¼W 5%	81349	5-10053	94
A1Q1	PN2907A	TRANSISTOR	07263	3-30285	95
A1Q2	PN2907A	TRANSISTOR	07263	3-30285	96
A1Q3	2N5246	TRANSISTOR	16067	3-30245	97
A1Q4	PE8550	TRANSISTOR	07263	3-30288	98
A1Q5	PE8050	TRANSISTOR	07263	3-30289	99
A1Q6	PN2222A	TRANSISTOR	07263	3-30284	100
A1Q7	CIC 376	TRANSISTOR	18324	3-30308	101
A1Q8	PN2222A	TRANSISTOR	07263	3-30284	102
A1S1	8-690-11	SWITCH 8 SECTION DIP	51167	2-40475	103
A1S2	8-690-11	SWITCH 8 SECTION DIP	51167	2-40475	104
A1S3	11975MP/REL-10-1	SWITCH ROTARY 10 POS	82104	2-40477	105
A1S4	11975MP/REL-10-1	SWITCH ROTARY 10 POS	82104	2-40477	106
A1S5	11975MP/REL-10-1	SWITCH ROTARY 10 POS	82104	2-40477	107
A1S6	11975MP/REL-10-1	SWITCH ROTARY 10 POS	82104	2-40477	108

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CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A1R46	RC07GF101J	RESISTOR 100Ω ¼W 5%	81349	5-10029	11
					11
A1T1	PC20-500	TRANSFORMER 115VAC	08779	7-10324	11
					11
					11
TP2/3/1	T-44	POST WIRE WRAP	82893	2-50303	11
					11
					11
					11
					11
A1U1	SN74167N	BCD RATE MULTIFIER	01295	3-60233	12
A1U2	SN74167N	BCD RATE MULTIFIER	01295	3-60233	12
A1U3	SN74167N	BCD RATE MULTIFIER	01295	3-60233	12
A1U4	SN74167N	BCD RATE MULTIFIER	01295	3-60233	12
A1U5	SN74LS74N	D FLIP-FLOP	07263	3-60161	12
A1U6	NE556N	TIMER	18324	3-60234	
A1U7	SN74LS04N	INVERTER	01295	3-60159	12
A1U8	SN74LS20	4 INPUT NAND	01295	3-60235	12
A1U9	LM340-5T	VOLTAGE REGULATOR	27014	3-60032	12
A1U10	LM78L10ACZ	VOLTAGE REGULATOR 10V	27014	3-60236	12
A1U11	SN74LS390N	DUAL DECADE COUNTER	01295	3-60226	13
A1U12	LM741EN	OP-AMP	27014	3-60237	13
A1U13	SN74LS669N	BINARY COUNTER	01295	3-60238	13
A1U14	SN74LS669N	BINARY COUNTER	01295	3-60238	13
A1U15	TL072CP	DUAL OP-AMP	01295	3-60213	13
A1U16	LM1458N	DUAL OP-AMP	27014	3-60270	13
A1U17	4850-011, RED	-PROM 256 X 4	16067	3-60272	13
A1U18	SN74LS669N	BINARY COUNTER	01295	3-60238	13
A1U19	4850-010, BROWN	-PROM 256 X 4	16067	3-60271	13
A1U20	SN74LS266N	EXCLUSIVE NOR	01295	3-60239	13
A1U21	NE5008N	8 BIT DAC	18324	3-60240	14
A1U22	SN74LS266N	EXCLUSIVE NOR	01295	3-60239	
					14
					14
					14

MODEL 850T/855T/853T | CALICO P/N 4850-700 | ASSY R.D

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PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
					145
A1Y1	HC33/U	CRYSTAL 10.2MHz ±.005%	000AH	2-50332	146
	25PF PARALLEL RESONANT IN HC33/U HOLDER				147
					148
					149
	C85-16-01	I.C. SOCKET U17,U19	01293	2-30057	150
					151
	05-3308	TRANSISTOR SOCKET Q7	91662	2-40294	152
					153
	HIGH VOLTAGE	DECAL .75 X 1.50	00544	1-20027	154
					155
					156
					157
					158
					159
					160
					161
					162
					163
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					165
					166
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					17
					17
					1
					180

MODEL 850T/855T/853T | CALICO P/N 4850-700 | ASSY R.D.

California Instruments

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A2	4850-702-1	PHASE P.C.B.	16067		1
A2	4850-702-2	A Ø SERVO P.C.B.	16067		2
A2	4850-702-3	PHASE/SERVO P.C.B.	16067		3
					4
					5
					6
	4850-702-7	P.C.B. MECH.	16067	1-60328	7
					8
C1	CK103	CAP. .01µF 50V	71590	6-10094	9
C2	CK103	CAP. .01µF 50V	71590	6-10094	10
C3	NOT USED				11
C4	CK103	CAP. .01µF 50V	71590	6-10094	12
C5	CK103	CAP. .01µF 50V	71590	6-10094	13
C6	CK103	CAP. .01µF 50V	71590	6-10094	14
C7	NOT USED				15
C8	CM05F821J03	CAP. 820PF 500V	81349	6-10050	16
C9	CM05F251J03	CAP. 250PF 500V	81349	6-10620	17
C10	C280AE/A100K	CAP. .1µF 250V	23445	6-10916	18
C11	C280AE/A100K	CAP. .1µF 250V	23445	6-10916	19
C12	T362B106M025AS	CAP. 10µF 25V	05397	6-10738	20
C13	160-1.0-M-100H	CAP. 1µF 100V	000AD	6-11059	21
C14	C280AE/A100K	CAP. .1µF 250V	73445	6-10916	22
C15	C280AE/A100K	CAP. .1µF 250V	73445	6-10916	23
C16	T362B106M025AS	CAP. 10µF 25V	05397	6-10738	24
C17	160-1.0-M100H	CAP. 1µF 100V	000AD	6-11059	25
C18	T362B106M025AS	CAP. 10µF 25V	05397	6-10738	26
C19	160-1.0-M-100H	CAP. 1µF 100V	000AD	6-11059	27
					28
CR1	IN4148	DIODE	25403	3-10227	29
CR2	IN4148	DIODE	25403	3-10227	30
CR3	IN4148	DIODE	25403	3-10227	31
CR4	IN4148	DIODE	25403	3-10227	32
CR5	IN4148	DIODE	25403	3-10227	33
CR6	IN4148	DIODE	25403	3-10227	34
					35
					36

MODEL 850T/855T/853T | CALICO P/N 4850-702 | ASSY R.D.

California Instruments

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
					37
J1	J-15-24-1-U-6.00-.125	CONNECTOR 15 PIN	08261	2-50339	38
J2	09-70-1041	CONNECTOR 4 PIN	27264	4-10289	39
J3	09-70-1041	CONNECTOR 4 PIN	27264	4-10289	40
J4	09-70-1041	CONNECTOR 4 PIN	27264	4-10289	41
					42
					43
Q1	CIC 376	TRANSISTOR	18324	3-30308	44
					45
					46
R1	898-1-R10K	RESISTOR 10K DIP	73138	3-60241	47
R2	RC07GF102J	RESISTOR 1K 1/4W 5%	81349	5-10053	48
R3	698-3-6.8K-F	RESISTOR 6.8K DIP	73138	3-60232	49
R4	RN55C4751F	RESISTOR 4.75K 1/8W 1%	81349	5-60752	50
R5	RC07GF472J	RESISTOR 4.7K 1/4W 5%	81349	5-10068	51
R6	698-3-6.8K-F	RESISTOR 6.8K DIP	73138	3-60232	52
R7	63P501	POTENTIOMETER 500Ω	02111	5-70266	53
R8	RN55D3322F	RESISTOR 33.2K 1/8W 1%	81349	5-60575	54
R9	RC07GF101F	RESISTOR 100Ω 1/4W 5%	81349	5-10029	55
R10	RC07GF104F	RESISTOR 100K 1/4W 5%	81349	5-10100	56
R11	63P501	POTENTIOMETER 500Ω	02111	5-70266	57
R12	RN55D8661F	RESISTOR 8.66K 1/4W 1%	81349	5-60747	58
R13	63P104	POTENTIOMETER 100K	02111	5-70265	59
R14	63P501	POTENTIOMETER 500Ω	02111	5-70266	60
R15	63P201	POTENTIOMETER 200Ω	02111	5-70258	61
R16	RC07GF223J	RESISTOR 22K 1/4W 5%	81349	5-10084	62
R17	764-1-R22K	RESISTOR 22K SIP	73138	3-60154	63
R18	RN55C2212F	RESISTOR 22.1K 1/8W 1%	81349	5-60766	64
R19	RN55D3832F	RESISTOR 38.3K 1/8W 1%	81349	5-60581	65
R20	63P253	POTENTIOMETER 25K	02111	5-70257	66
R21	C98-3-R-20K-F	RESISTOR 20K DIP	73138	3-60266	67
R22	63P102	POTENTIOMETER 1K	02111	5-70261	68
R23	RC07GF334J	RESISTOR 330K 1/4W 5%	81349	5-10112	69
R24	RN60C3743F	RESISTOR 374K 1/8W 1%	81349	5-60484	70
R25	RN60C3743F	RESISTOR 374K 1/8W 1%	81349	5-60484	71
					72

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ASSY R.D.

TITLE PHASE/SERVO

California Instruments

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PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
R26	RN60C3743F	RESISTOR 374K 1/4W 1%	81349	5-60484	73
R27	RN60C3743F	RESISTOR 374K 1/4W 1%	81349	5-60484	74
R28	RC07GF102J	RESISTOR 1K 1/4W 5%	81349	5-10053	75
R29	RC07GF102J	RESISTOR 1K 1/4W 5%	81349	5-10053	76
R30	RC07GF103J	RESISTOR 10K 1/4W 5%	81349	5-10076	77
R31	RC07GF103J	RESISTOR 10K 1/4W 5%	81349	5-10076	78
R32	RC07GF153F	RESISTOR 15K 1/4W 5%	81349	5-10080	79
R33	63P253	POTENTIOMETER 25K	02111	5-70257	80
R34	698-3-R-20K-F	RESISTOR 20K DIP	73138	3-60266	81
R35	63P102	POTENTIOMETER 1K	02111	5-70261	82
R36	RC07GF334J	RESISTOR 330K 1/4W 5%	81349	5-10112	83
R37	RN60C3743F	RESISTOR 374K 1/4W 1%	81349	5-60484	84
R38	RN60C3743F	RESISTOR 374K 1/4W 1%	81349	5-60484	85
R39	RN60C3743F	RESISTOR 374K 1/4W 1%	81349	5-60484	86
R40	RN60C3743F	RESISTOR 374K 1/4W 1%	81349	5-60484	87
R41	RC07GF102J	RESISTOR 1K 1/4W 5%	81349	5-10053	88
R42	RC07GF102J	RESISTOR 1K 1/4W 5%	81349	5-10053	89
R43	RC07GF103J	RESISTOR 10K 1/4W 5%	81349	5-10076	90
R44	RC07GF103J	RESISTOR 10K 1/4W 5%	81349	5-10076	91
R45	RC07GF153F	RESISTOR 15K 1/4W 5%	81349	5-10080	92
R46	63P253	POTENTIOMETER 25K	02111	5-70257	93
R47	698-3-R-20K-F	RESISTOR 20K DIP	73138	3-60266	94
R48	63P102	POTENTIOMETER 51K	02111	5-70261	95
R49	RC07GF334J	RESISTOR 330K 1/4W 5%	81349	5-10112	96
R50	RN60C3743F	RESISTOR 374K 1/4W 1%	81349	5-60484	97
R51	RN60C3743F	RESISTOR 374K 1/4W 1%	81349	5-60484	98
R52	RN60C3743F	RESISTOR 374K 1/4W 1%	81349	5-60484	99
R53	RN60C3743F	RESISTOR 374K 1/4W 1%	81349	5-60484	100
R54	RC07GF102J	RESISTOR 1K 1/4W 5%	81349	5-10053	101
R55	RC07GF102J	RESISTOR 1K 1/4W 5%	81349	5-10053	102
R56	RC07GF103J	RESISTOR 10K 1/4W 5%	81349	5-10076	103
R57	RC07GF103J	RESISTOR 10K 1/4W 5%	81349	5-10076	104
R58	RC07GF153F	RESISTOR 15K 1/4W 5%	81349	5-10080	105
R59	RC07GF100J	RESISTOR 10Ω 1/4W 5%	81349	5-10005	106
R60		NOT USED			107
R61	RC07GF100J	RESISTOR 10Ω 1/4W 5%	81349	5-10005	108

MODEL 850T/855T/853T

CALICO P/N 4850-702

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TITLE PHASE/SERVO

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California Instruments	CODE IDENT 16067	PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
R62		NOT USED			109
R63	RC07GF100J	RESISTOR 10Ω 1/4W 5%	81349	5-10005	110
R64		NOT USED			111
R65		NOT USED			112
R66	RC07GF100J	RESISTOR 10Ω 1/4W 5%	81349	5-10005	113
R67	RC07GF100J	RESISTOR 10Ω 1/4W 5%	81349	5-10005	114
R68		NOT USED			115
R69		NOT USED			116
R70	RC07GF100J	RESISTOR 10Ω 1/4W 5%	81349	5-10005	117
R71		NOT USED			118
R72		NOT USED			119
R73	RC07GF102J	RESISTOR 1K 1/4W 5%	81349	5-10053	120
R74	RC07GF101J	RESISTOR 100Ω 1/4W 5%	81349	5-10029	121
R75	RC07GF101J	RESISTOR 100Ω 1/4W 5%	81349	5-10029	122
TP3-TP5					123
TP12	T44	WIRE WRAP POST	82893	2-50303	124
S1		NOT USED			125
					126
U1	SN74LS669N	BINARY COUNTER	01295	3-60238	127
U2	SN74LS669N	BINARY COUNTER	01295	3-60238	128
U3	SN74LS669N	BINARY COUNTER	01295	3-60238	129
U4	4850-011, RED	PROM 256X4	16067	3-60272	130
U5	4850-010, BROWN	PROM 256X4	16067	3-60271	131
U6	SN74LS00N	QUAD NAND GATE	01295	3-60156	132
U7	SN74LS266N	EXCLUSIVE NOR	01295	3-60239	133
U8	SN74LS266N	EXCLUSIVE NOR	01295	3-60239	134
U9	NE5008N	8 BIT DAC	18324	3-60240	135
U10	TL072CP	DUAL OP-AMP	01295	3-60213	136
U11	LM1458N	DUAL OP-AMP	27014	3-60270	137
U12	LM1458N	DUAL OP-AMP	27014	3-60270	138
U13	TL072CP	DUAL OP-AMP	01295	3-60213	139
U14	TL072CP	DUAL OP-AMP	01295	3-60213	140
U15	CLM51	PHOTO-CELL	03911	3-60256	141
U16	TL072CP	DUAL OP-AMP	01295	3-60213	142
U17	TL072CP	DUAL OP-AMP	01295	3-60213	143
U18	CLM51	PHOTO-CELL	03911	3-60256	144

California Instruments	CODE IDENT 16067	PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
U19	TL072CP	DUAL OP-AMP	01295	3-60213	145
U20	TL072CP	DUAL OP-AMP	01295	3-60213	146
U21	CLM51	PHOTO-CELL	03911	3-60256	147
					148
					149
					150
	05-3308	TRANSISTOR SOCKET Q1	91662	2-40294	151
	C85-16-01	I.C. SOCKET U4/U5	06776	2-30057	152
					153
XJ2	09-50-3041	CONNECTOR 4 PINS	27264	4-10291	154
XJ3	09-50-3041	CONNECTOR 4 PINS	27264	4-10291	155
XJ4	09-50-3041	CONNECTOR 4 PINS	27264	4-10291	156
					157
	08-56-0106	CONTACTS	27264	4-10293	158
					159
					160
					161
					162
					163
					164
					165
					166
					167
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					179
					180

MODEL 850T/855T/853T	CALICO P/N 4850-702	ASSY R.D.
TITLE PHASE/QE KIT	SHT 05	A2

SECTION VIII
OPTIONS

8-1 GENERAL

8-2 This section of the manual contains information regarding all available options.

MANUAL ADDENDUM
Model 850T/855T/853T - 1, 2, or 3A
(Otherwise referred to as Option A)

1.0 GENERAL

The Model 850T/855T/853T with Option A has a frequency accuracy of 0.00001%.

2.0 SPECIFICATIONS

All standard Model 850T/855T/853T specifications apply except for the following:

FREQUENCY ACCURACY: 0.00001% at 23°C.

3.0 CALIBRATION

Connect a counter input to A1TP2 and the ground available at the right hand side of A1C21. Adjust A1C7 until the frequency counter indicates 10.20000 MHz $\pm$ 1 count ($\pm$ 10 Hz.).

MANUAL ADDENDUM

1.0 MODEL NUMBER DESCRIPTION

All oscillators in the 85XT Series have a number that describes the frequency selection, number of servoed or unservoed outputs and method of amplitude control.
The first designation is either the 850T, 853T or 855T.

1.1 PHASE DESIGNATION

The next portion of the oscillator model number indicates the number of unservoed outputs. If the number of phases is followed by the designator "S", the outputs are servoed.

For example:

XXX-1	Single Phase
XXX-2	Two Phase (Phase C leading A by 90^{o})
XXX-3	Three Phase
XXX-3D	Two-Phase open delta (Phase C leading A by 60^{o})
XXX-1S	Single Phase servoed

1.2 AMPLITUDE PROGRAM

The last designator, if present, indicates the optional methods of externally programming the output amplitude.

XXX-XX-RPV	indicates programming by DC voltage.
XXV-XX-RPR	indicates programming by resistance.

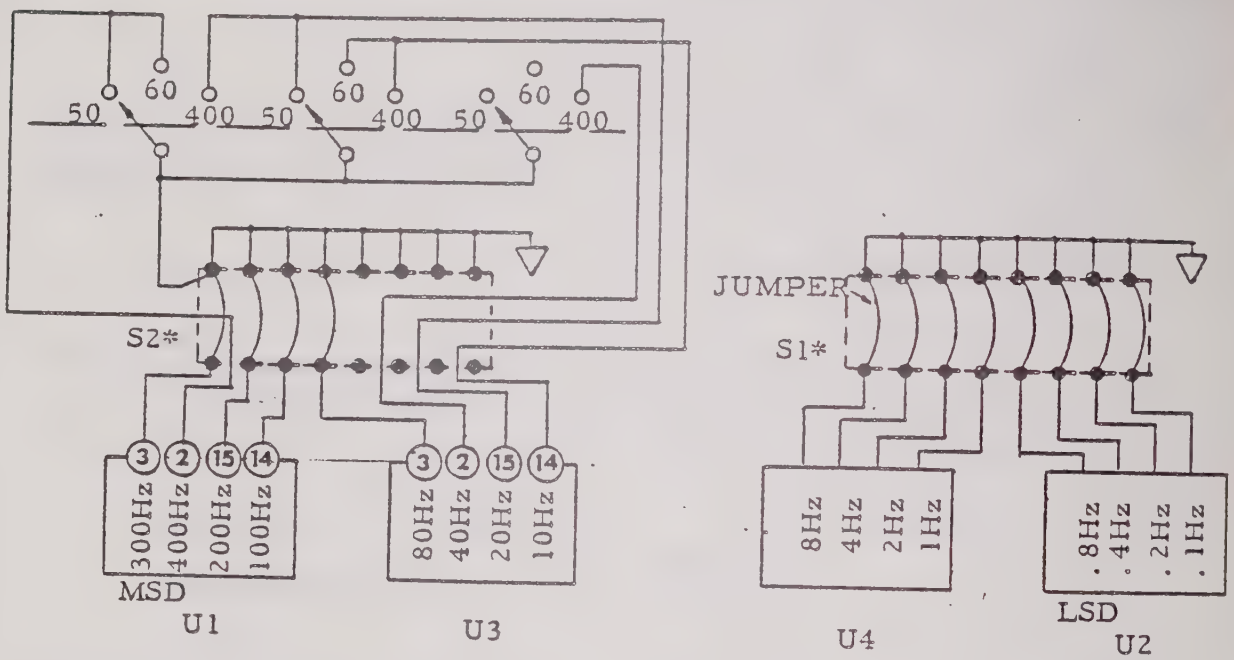
2.0 MODEL 853T

2.1 GENERAL

The 853T oscillator is identical to an 855T, except any of three frequencies--50Hz, 60Hz, and 400Hz--can be selected.

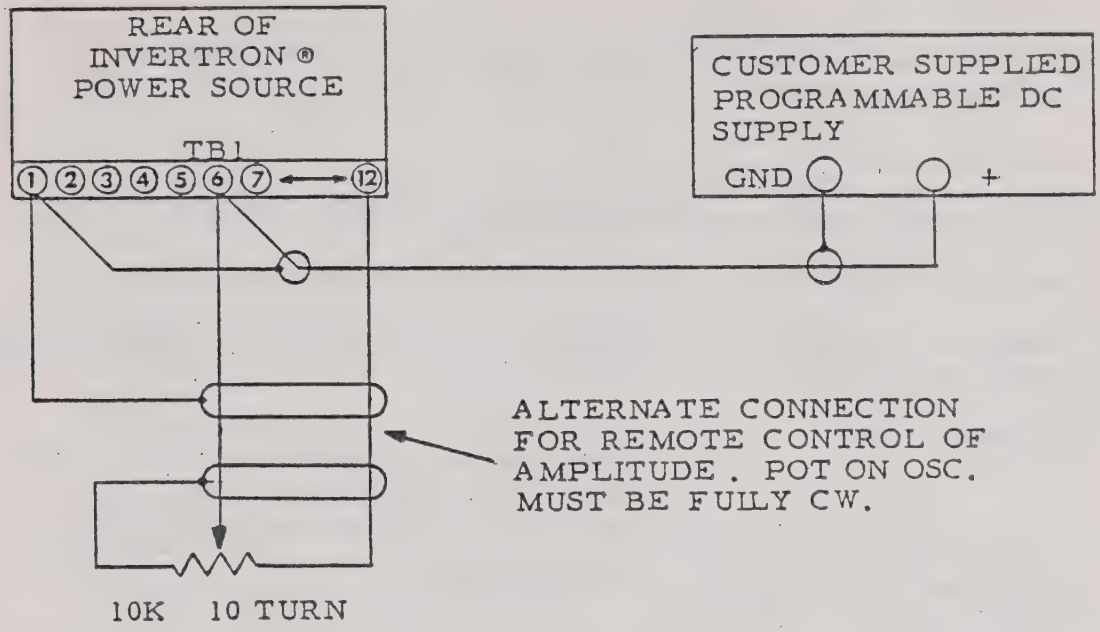
2.2 THEORY OF OPERATION

Refer to Figure 6-4 in the standard 855T Instruction Manual. DIP switches S1 and S2 are removed for the 853T. Switch S1 is replaced by jumpers and S2 is wired to the front panel 50, 60, 400Hz selector switch. Refer to Figure 1 of this addendum. Range jumper W3 is installed instead of W1 to enable the 999.9Hz frequency range.



*NOTE:
S1 and S2 are removed to allow wiring to frequency selector switch 22Ω DIP resistor may be substituted for jumpers at S1 .

853T FREQUENCY PROGRAMING
FIGURE 1



CONNECTIONS FOR DC
PROGRAMING
FIGURE 2

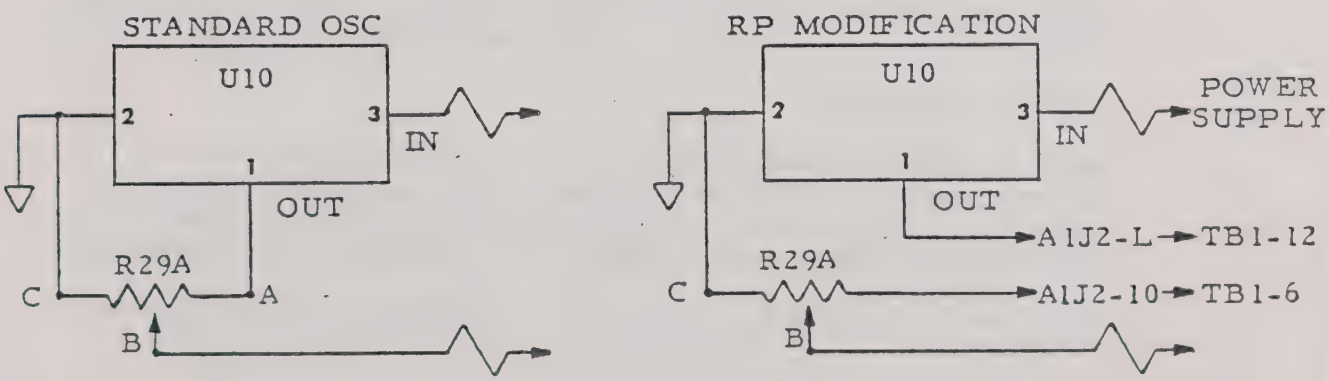


FIGURE 3

3.0 RPV OPTION

3.1 GENERAL

The RPV option allows the power system's output amplitude to be DC programmable .

3.2 SPECIFICATIONS

All standard specifications apply except for the following:

AMPLITUDE STABILITY:	Determined by DC programming source.
AMPLITUDE TEMPERATURE COEFFICIENT:	Determined by DC programming source.
DC PROGRAMMING VOLTAGE:	+30VDC MAX. into 10KΩ impedance +10VDC represents maximum oscillator output (5VRMS) with the oscillator pot full clockwise.
SLOW START:	Not functional.

3.3 PROGRAMMING

The DC programming voltage must be applied across pin 6 and pin 1 on TB1 at the rear panel of the power source. Pin 6 must be the positive input. See Figure 2 . If a DC voltage greater than +10V is to be used, the oscillator front panel AMPLITUDE control must be reduced to keep the oscillator and power source output within their operating ranges. The power source full scale output is obtained by an output of approximately 5VRMS from the oscillator.

3.4 REMOTE GAIN CONTROL

The +10Volt reference is available at pin 12 of TB1 on rear of power source and this may be used in conjunction with a 10KΩ potentiometer to control the output amplitude of the power source. See Figure 2 .

3.5 THEORY OF OPERATION

See Main Board schematic number 4850-070. Instead of R29A connecting to A1U10-1, R29A connects to A1J2-10, and A1U10-1 connects to A1J2-12. This removes A1U10, the +10 volt reference, from circuit and allows an external power supply to be substituted. See Figure 3 .

The standard slow start feature is not functional in these versions of the oscillator.

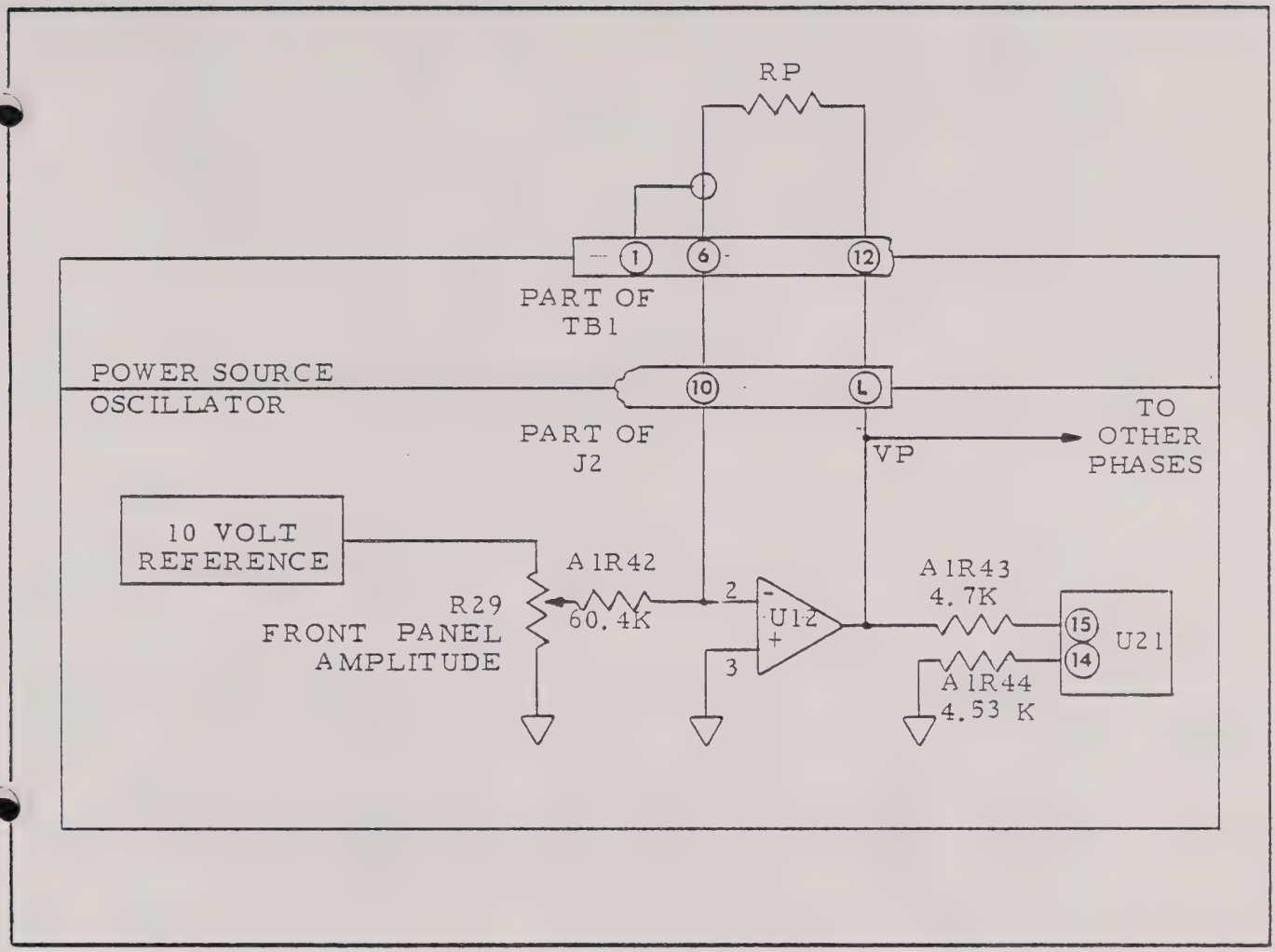


DIAGRAM OF RPR
FIGURE 4

4.0 RPR OPTION

4.1 GENERAL

The RPR option allows the output amplitude of the power system to be controlled by a variable resistance.

4.2 SPECIFICATIONS

RANGE	AMPLITUDE CONTROL (Ω/V) minimum
135/270	444/222
130/260	462/231
120/240	500/250

All other specifications are the same as the standard oscillator.

4.3 THEORY OF OPERATION

A diagram of the RPR configuration is shown in Figure 4. The operational amplifier A1U12 is operating in the inverting mode such that its output voltage Vp is proportional to the remote programming resistance Rp. The remote programming sensitivity can be increased by the setting of the oscillator amplitude control R29. Since the output of the reference amplifier U12 is negative with the RPR configuration, the "-" input of all DAC'S must receive the amplitude programming voltage.

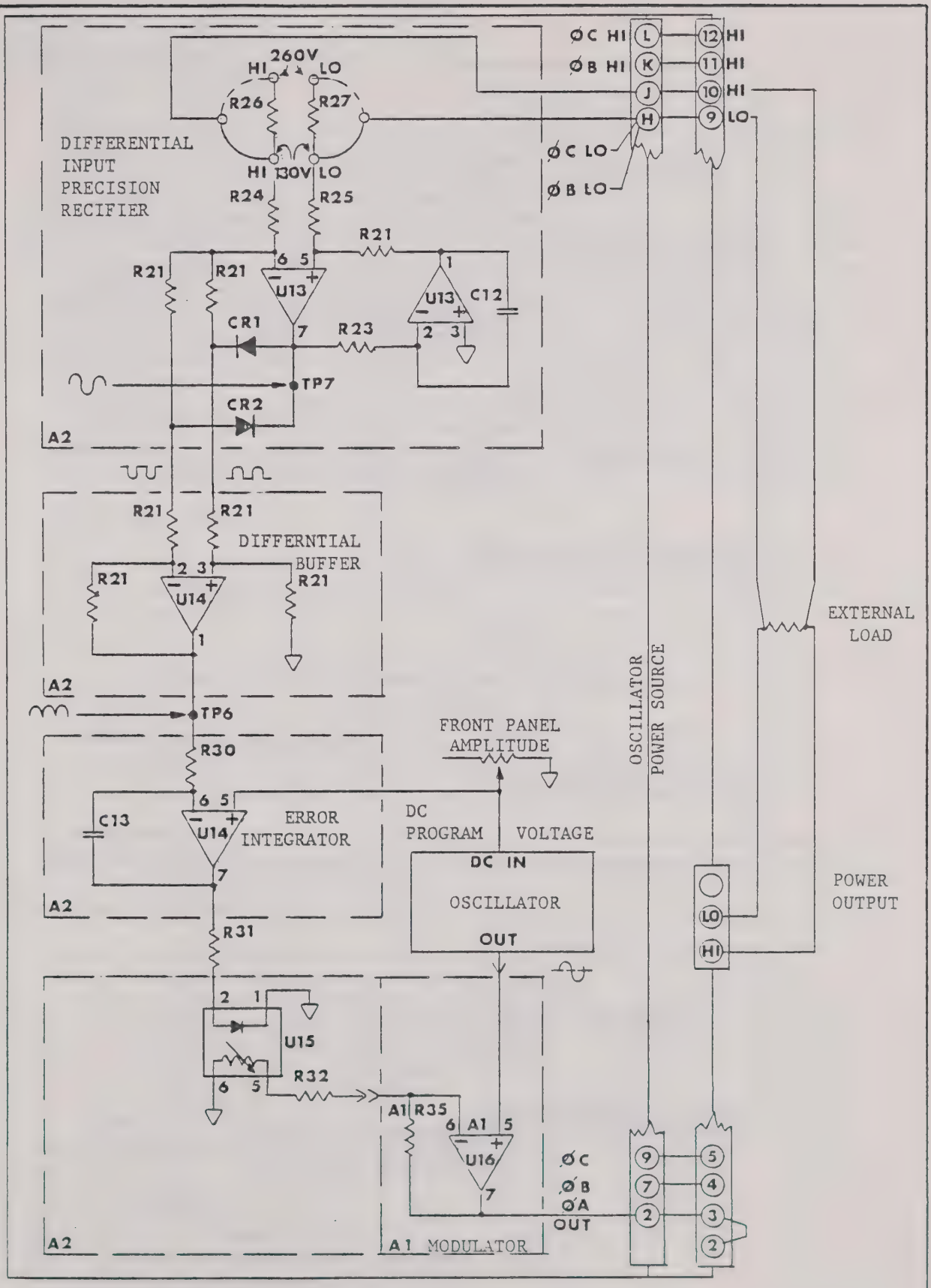
4.4 CALIBRATION

Select a resistor that represents the full scale output voltage of the power source. (ex: Range=120, Rp=120X.5K=60K)
Connect this resistor across terminals 6 and 12 of TB1 on the rear of the power source. While monitoring the power source output voltage adjust the oscillator amplitude control and power source gain control to 120.0 Volts

5.0 SERVO OPTION

5.1 GENERAL

All model 85X series oscillators can be used with the servo option. The servo option is not available with either the RPV or RPR options . The servo option allows the power source output to be precisely regulated at a distance from the power source .



SERVO CONFIGURATION
FIGURE 5

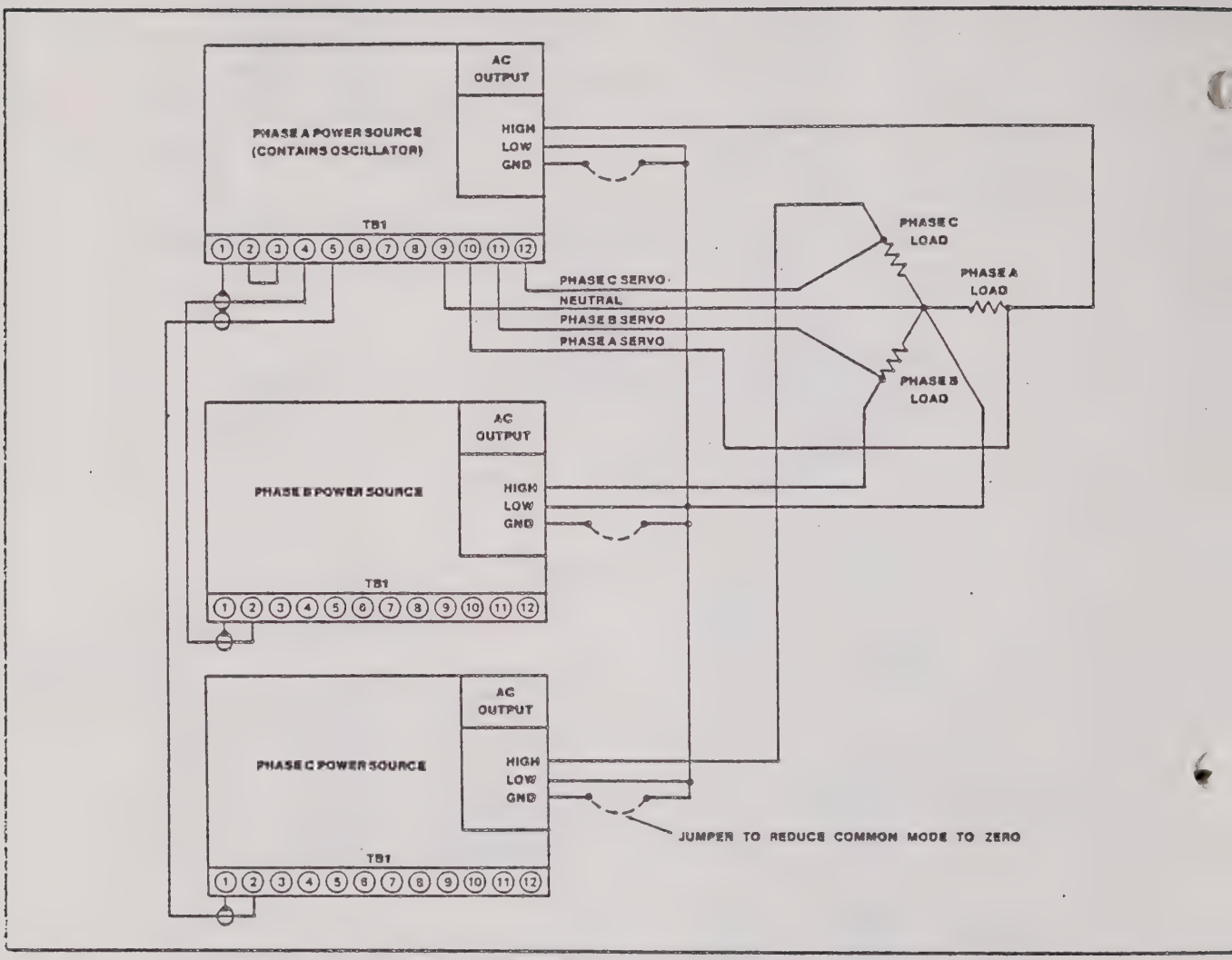


Figure 6_A Polyphase Power Source System Connections Using Individual Units.

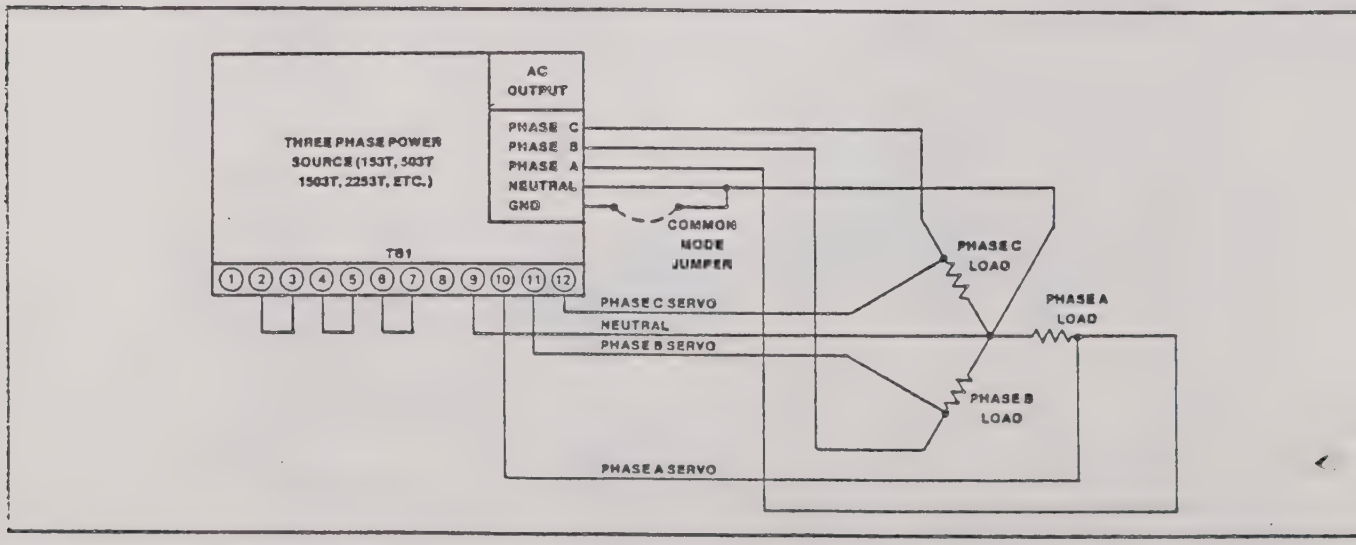


Figure 6 B Polyphase Power Source System Connections Using Single Unit.

5.2 THEORY OF OPERATION

The operation of the Phase A servo is shown in Figure 5. The operation of the Phase Band C servoes is identical to that of Phase A. The output amplitude of the power system is set by the oscillator front panel AMPLITUDE adjustment. This DC voltage is sent to the oscillator which generates a sinewave with an amplitude proportional to the DC program voltage. The oscillator output is routed through the MODULATOR and then to the power source which amplifies the signal to the appropriate level. The amplitude of the voltage is sensed across the load by differential input of the PRECISION RECTIFIER. The two half-wave outputs of the PRECISION RECTIFIER are changed to positive full wave by the DIFFERENTIAL BUFFER. The DIFFERENTIAL BUFFER output at TP6 is a voltage with a DC component proportional to the voltage sensed across the load. The DC component of this voltage is compared with the DC program voltage at the input of the ERROR INTEGRATOR. The ERROR INTEGRATOR output drives the MODULATOR to increase or decrease the drive to the power source to keep the DC component of the sense voltage equal to the DC program voltage.

5.3 SERVO CALIBRATION

5.3.1 With the servo inputs disconnected, adjust the distortion and amplitude controls identical to the procedure for an unservoed oscillator.

5.3.2 Short the common mode voltage by shorting the servo neutral input to analog common. (short TB1-1 to TB1-9)

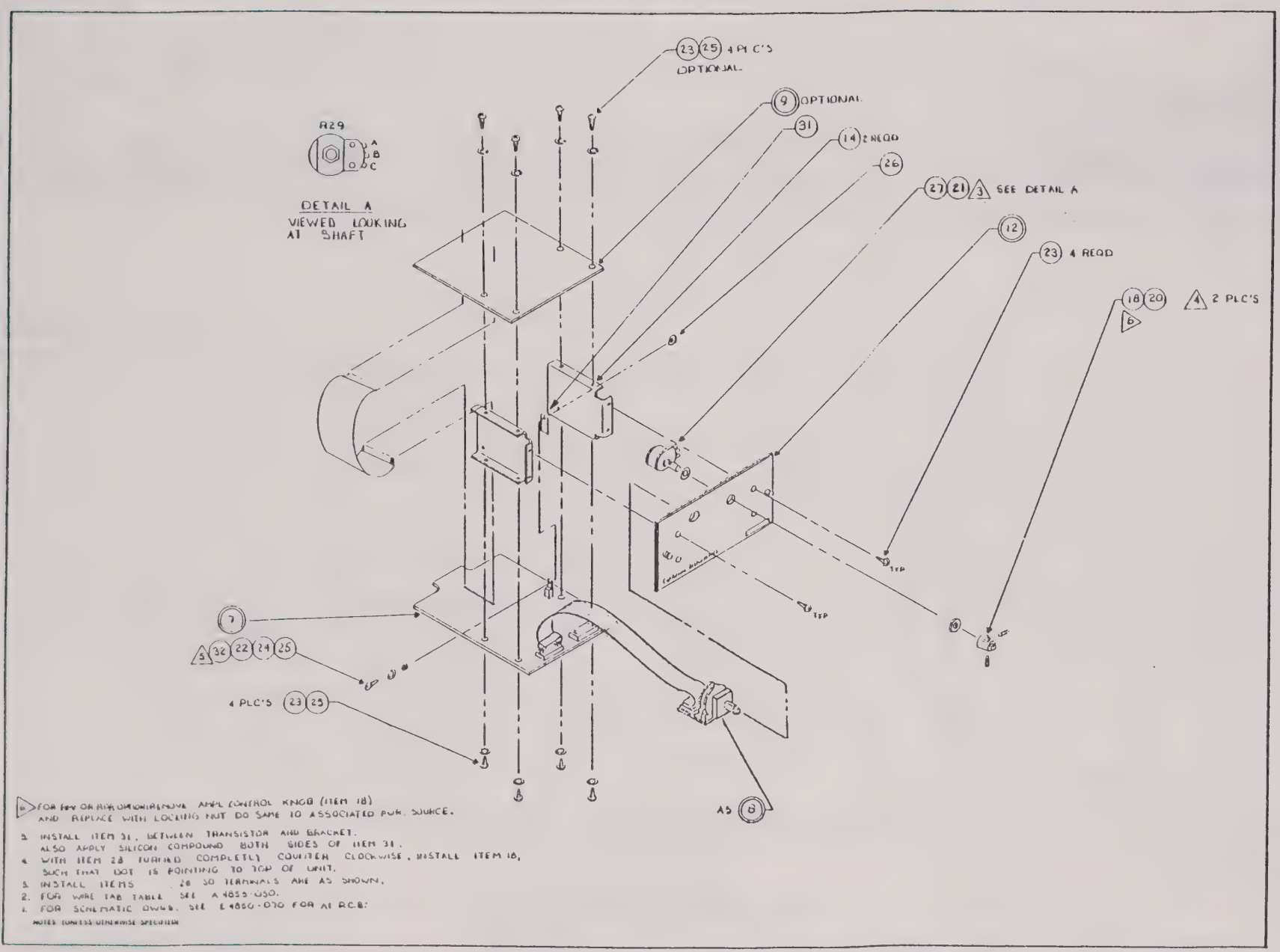
5.3.3 Set the oscillator front panel AMPLITUDE adjustment to its maximum clockwise position. Increase the front panel GAIN control of each power source until the output of each phase is full scale +10%. (ex: 148V for 135 volt range)

5.3.4 Close the servo loop of each phase by connecting the servo inputs (Pins 9,10,11,12 of TB1) across the load. See Figure 6. Adjust the full scale pot of each to the full scale voltage. See Table 1.

5.3.5 Remove the common mode short added in Step 5.3.2 . TB1-10,11 and 12 are the Phase A, B and C servo sense HI inputs respectively. Alternately short each servo sense HI input and adjust the common mode pot of each phase to the full scale values recorded in Step 5.3.4 .

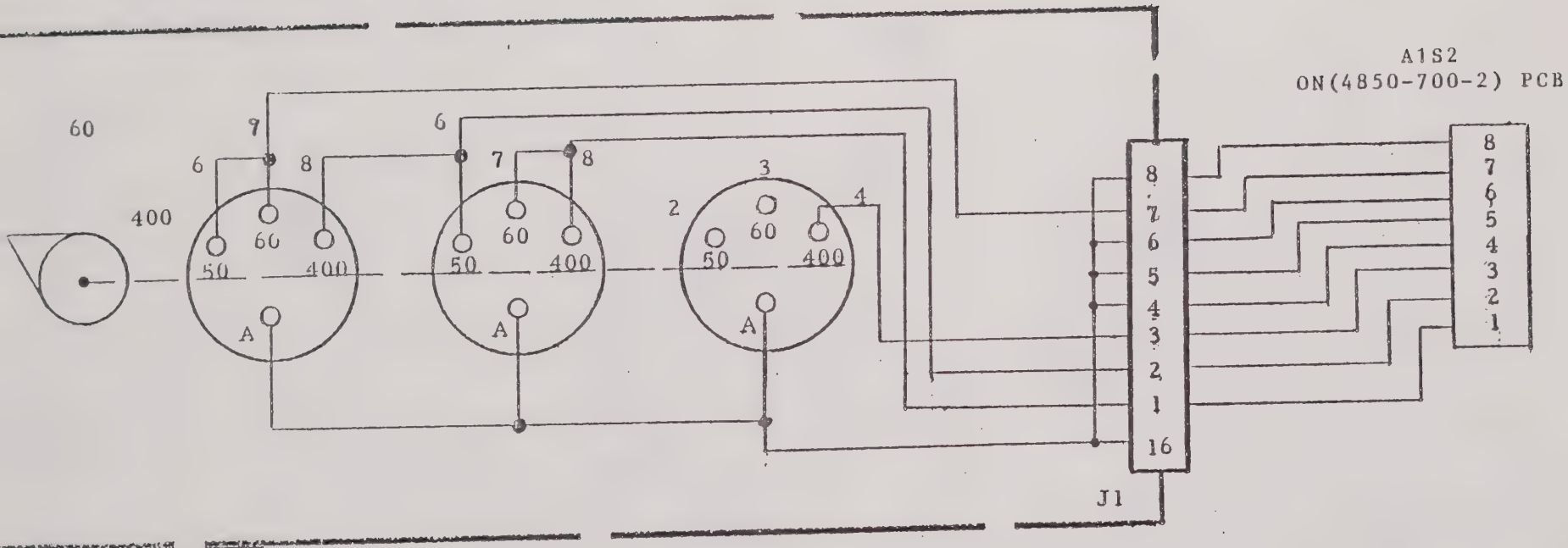
PHASE	STEP 5.3.3 OPEN SERVO ADJUSTMENT	STEP 5.3.4 FULL SCALE ADJUSTMENT	STEP 5.3.5 COMMON MODE ADJUSTMENT
A	PHASE A SOURCE GAIN CONTROL	A2 R20	A2 R22
B	PHASE B SOURCE GAIN CONTROL	A2 R33	A2 R35
C	PHASE C SOURCE GAIN CONTROL	A2 R46	A2 R48

TABLE 1


(23)(25) 4 PL C'S
OPTIONAL
(9) OPTIONAL
(31)
(14) 2 REQD
(26)
(27)(21)(3) SEE DETAIL A
(12)
(23) 4 REQD
(18)(20) (4) 2 PLC'S
(6)
A29
A
B
C
DETAIL A
VIEWED LOOKING AT SHAFT
(7)
(5)(32)(22)(24)(25)
4 PLC'S (23)(25)
(8)
TYP
TYP
(1) FOR FM OR AM OPTIONAL REMOVE AMPL CONTROL KNOB (ITEM 18) AND REPLACE WITH LOCKING NUT DO SAME TO ASSOCIATED PWR. SOURCE.
3. INSTALL ITEM 31, BETWEEN TRANSISTOR AND BRACKET. ALSO APPLY SILICON COMPOUND BOTH SIDES OF ITEM 31.
4. WITH ITEM 28 TURNED COMPLETELY COUNTER CLOCKWISE, INSTALL ITEM 18, SUCH THAT DOT IS POINTING TO TOP OF UNIT.
5. INSTALL ITEMS 28 30 TERMINALS ARE AS SHOWN.
2. FOR WIRE TAB TABLE SEE A 855T-050.
1. FOR SCHEMATIC DWGS. SEE E 850-070 FOR AT RCB:
NOTES UNLESS OTHERWISE SPECIFIED

Assembly Diagram, Model 853T Oscillator.

853T
50/60/400HZ



4850-705-1 | A4

DIM IN INCHES TOLERANCES .XXX = .010 .XX = .03 X° = 30′	BREAK ALL SHARP CORNERS & EDGES MACH SURFACES ✓	DWG B SIZE	TITLE FREQUENCY SELECT- SCHEMATIC DIAGRAM

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALICO. AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION.

MODEL 853T

RELEASE					
CHECKER	W Duckek	12/79	PURCHASING		
DESIGN			PROJ ENGR	D McFarlane	12/79

CALICO
CALIFORNIA INSTRUMENTS CORP.
SAN DIEGO, CALIFORNIA

CONTRACT NO.

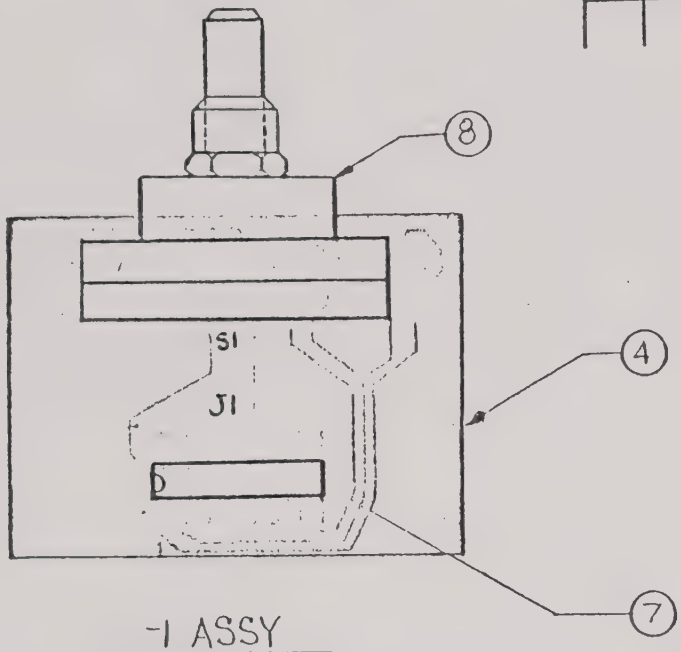
CODE IDENT 16067

DWG NO. 4850-076

RE —

—	4850-705

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD



-1 ASSY

REQD PER ASSY	ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE

DIM IN INCHES TOLERANCES	BREAK ALL SHARP CORNERS & EDGES	DWG SIZE
.XXX = .010 .XX = .03 X° = 30'	MACH SURFACES ✓	B

TITLE: FREQUENCY SELECT- P.C. BOARD ASSEMBLY...

MODEL 853T

CALICO
CALIFORNIA INSTRUMENTS CORP.
SAN DIEGO, CALIFORNIA

CONTRACT NO.

CODE IDENT 16067

DWG NO. 4850-705

REV —

SCALE 2/1

SHEET 2 OF 4

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RELEASE			
CHECKER	[illegible]	1/9	PURCHASING
DESIGN			PROJ ENGR D. McFarlane 12/71
DRFTSMN	M. SANCHEZ	11-9-71	CHF ENGR

DASH	QTY	NEXT	EFF ON	AUTH

1. CLAD SHOWN IS FAR SIDE.

NOTES: (UNLESS OTHERWISE SPECIFIED)

California Instruments

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
					1
	4850-406-1	853T	16067		2
					3
					4
					5
					6
A1	4850-700-3	P.C. Board Assy Mian A1	16067		7
A4	4850-705-1	P.C. Board Assy	16067		8
A2	4850-702-1	P.C. Board Assy	16067		9
					10
					11
	C4850-208-1	Front Panel	16067	1-10738	12
					13
	C4850-201-7	Side Panel	16067	1-10699	14
					15
	5242-004	Conn. Ribbon	08261	4-10275	16
					17
	PS-70D-2-BLK	Knob, W/Dot , BLK	21604	2-10191	18
					19
		Nut 1/2HEX 3/8-32	81349	2-10187	20
	5/16 I.D. .02THK	Washer 1/2O.D.			21
	4-40 x3/8 Lg.	Screw Mach. HD. Pan	81349		22
	4-40 x 3/8 PHP. Pan	Screw Self-Cutting Type (D)	81349		23
	NY04-040	Shoulder Washer	08289	2-10076	24
	#4	Washer Split Lock			25
	#4-40	Hex Nut			26
R29	B4010-012-1	Potentiometer , 10K	16067	5-70123	27
					28
					29
					30
	4673	Mica , Washer	91833	2-10474	31
		Silicon Compound			32
					33
					34
					35
					36

MODEL 853T | CALICO P/N 4850-406 | ASSY R.D.

California Instruments

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
	4850-705-1	P. C. BOARD ASSY	16067		1
					2
					3
	4850-705-7	P. C. BOARD	16067	1-60323	4
					5
					6
J1	C85-16-01	I. C. SOCKET 16PIN	16067	2-30057	7
S1	1120-011	SWITCH - ROTARY	16067	2-40450	8
					9
					10
					11
					12
					13
					14
					15
					16
					17
					18
					19
					20
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					33
					34
					35
					36

MODEL 3F3T | CALICO P/N 4850-705 | ASSY R.D.

California Instruments

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
	4850-410-1	RPR OPTION			1
	4850-410-2	SQUARE WAVE OPTION			2
	4850-410-3	RPR/SQUARE WAVE OPTION			3
----------	DELETE FOR	4850-700 (A1) PCB ----------			4
C19	CM05F251J03	CAPACITOR 250pF 500V	02799	6-102620	5
C20	CMO5F821J03	CAPACITOR 820pF 500V	02799	6-10050	6
R21	RC07GF103J	RESISTOR .10K 1/4W 5%	81349	5-10076	7
R26	RN55D4531F	RESISTOR 4.53K 1%	81349	5-60748	8
R28	RC07GF472J	RESISTOR 4.7K 1/4W 5%	81349	5-10068	9
U12	LM741EN	OP-AMP	27014	3-60237	10
U17	4850-011, RED	IC-PROM 256x4 16PIN	16067	3-60109	11
U19	4850-010, BRN	IC-PROM 256x4 16PIN	16067	3-60109	12
----------	DELETE FOR	4850-702 (A2) PCB (IF REQUIRED)----------			13
C8	CMO5F821J03	CAPACITOR 820pF 500V	81349	6-10050	14
C9	CMO5F251J03	CAPACITOR 250pF 500V	81349	6-10620	15
R4	RN55C4751F	RESISTOR 4.74K 1/8W 1%	81349	5-60752	16
R5	RC07GF472J	RESISTOR 4.7K 1/4W 5%	81349	5-1068	17
U4	4850-011, RED	IC-PROM 256x4 16PIN	16067	3-60109	18
U5	4850-010, BRN	IC-PROM 256x4 16PIN	16067	3-60109	19
					20
----------	ADD TO 4850-700 (A1) PCB ----------				21
R42	RN60E604F	RESISTOR 60.4K 1/8W 1%	81349	5-60492	22
R43	RC07GF472J	RESISTOR 4.7K 1/4W 5%	81349	5-10068	23
R44	RN55D4531F	RESISTOR 4.53K 1%	81349	5-60748	24
U12	LF356N	I.C.	27014	3-60217	25
	C19, C20, R26, R28, U17, U19 NOT USED				26
					27
----------	ADD TO 4850-702 (A2) PCB (IF REQUIRED)----------				28
R71	RN55C4751F	RESISTOR 4.75K 1/8W 1%	81349	5-60752	29
R72	RC07GF472J	RESISTOR 4.7K 1/4W 5%	81349	5-10068	30
	C8, C9, R4, R5, U4, U5, NOT USED				31
					32
					33
					34
					35
					36

MODEL 850T/855T/853T | CALICO P/N 4850-410 | ASSY R.D.

APPENDIX A

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbook H4-1 and its latest supplement. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbook.

0000A	ElectriCord	Westfield	PA
0000A	OK Machine and Tool Corp.	New York	NY
0000A	Fairmat	Harbor City	CA
0000B	Tech. Prod. Sales	Sarrosa Valley	CA
0000C	Jaeger Bros.	Waddon, Surrey	GB
0000D	Chicago Std. Transformer Co.	Chicago	IL
0000E	Use Code #00289		
0000F	Calvern	Santa Monica	CA
0000G	Use Code #30983		
0000H	Mfgl of Ilmiy c/o Q.C. Components	Los Angeles	CA
0000I	Use Code #50522		
0000J	Use Code #34333		
0000K	Elma	Schweiz	CH
0000L	Use Code #32293		
0000M	Use Code #16950		
0000N	Use Code #15912		
0000P	Mesa Office Supply	San Diego	CA
0000R	American Handle	Philadelphia	PA
0000S	OPCDA	Edison	NJ
0000T	Use Code #31743		
0000U	Use Code #32293		
0000V	Fairmat	Los Angeles	CA
0000W	Milton Roos Co.	Southampton	PA
0000X	Use Code #52072		
0000Y	Use Code #29990		
0000Z	Timco	Los Angeles	CA
00141	Pic Design Corp.	E. Rockaway	NY
00194	Waisco Electromes Corporation	Los Angeles	CA
00544	Metal-Cal Div., Avery Prod. Corp.	Inglewood	CA
00656	Aerovox Corporation	New Bedford	MA
00779	AMP, Inc.	Harrisburg	PA
00853	Sangamo Electric Company	Pickens	SC
00866	Gen Eng. Co., Inc.	City of Industry	CA
01121	Allen-Bradley Company	Milwaukee	WI
01179	Ajax Magnethermic Corp.	NE Warren	OH
01255	Litton Industries, Inc.	Beverly Hills	CA
01281	T R W Semiconductors, Inc.	Lawndale	CA
01295	Texas Instruments, Inc.	Dallas	TX
02111	Spectrol Electronics	City of Industry	CA
02114	Ferroxcube Corp.	Saugerties	NY
02339	Fairchild Controls Corp.	Hicksville, LI	NY
02660	Amphenol Corporation	Broadview	IL
02799	Use Code #72136		
03507	General Electric Company	Syracuse	NY
03508	General Electric Company	Syracuse	NY
03516	General Electric Company	Somersworth	NH
03797	Eldema Corporation	Compton	CA
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls	NJ
03911	Clairex Corporation	New York	NY
04009	Arrow-Hart and Hegeman Elec. Co.	Hartford	CT
04062	Use Code #72136		
04713	Motorola Semiconductor Prod., Inc.	Phoenix	AZ
04963	3-M	St. Paul	MN
05236	Jonathan Mfg. Co.	Fullerton	CA
05276	Pomona Electronics Co., Inc.	Pomona	CA
05347	Ultronix	Grand Junction	CO
05397	Kemet, Union Carbide Corp.	Cleveland	OH
05820	Wakefield Engineering, Inc.	Wakefield	MA
06046	Dixon Meter	Grand Junction	CO
06184	Connico Components	San Bernadino	CA
06223	Koolitronic Fan Company	Princeton	NJ
06229	Electrovert, Incorporated	Mt. Vernon	NY
06383	Panduit Corp.	Tinley Park	IL
06514	Stanitron, Wyco Metal Products	N. Hollywood	CA
06540	Amathom Elect. Hardward	New Rochelle	NY
06682	Magnetic Shield Div.	Chicago	IL
06776	Robinson, Nugent, Inc.	New Albany	IN
06915	Richco Plastics, Co.	Chicago	IL
07088	Kelvin Electric Company	Van Nuys	CA
07115	Use Code #14674		
07256	Silicon Transistor Corp.	Garden City	NY
07261	Fairchild Camera and Instr. Corp.	Mt. View	CA
07387	Birtcher Corporation	Los Angeles	CA
07596	Unitrack Calabro Plastics	Upper Darby	PA
07633	Epoxy Prod. Co. Div. of Allied Prod. Corp.	New Haven	CT
07713	Sperry Rand Corporation	Norwalk	CT
07716	I R C Incorporated	Burrington	IA
07910	Continental Devices	Hawthorne	CA
08045	Accurate Rubber and Plastics Co.	San Diego	CA
08261	Spectra Strip	Garden Grove	CA
08289	Blinn-Delbert Co., Inc.	Pomona	CA
08594	Elmac Div. of Varian Associates	Salt Lake	UT
08718	Use Code #71468		
08730	Vemaline Products Co.	Franklin Lakes	NJ
09026	Babcock Electronics Corp.	Costa Mesa	CA
09169	Atohm, Technical Industries, Inc.	Burbank	CA
09353	C and K Components, Inc.	Newton	MA
11432	Diamond Metal Sales	Gardena	CA
11815	Cherry Rivet Div., Townsend Co.	Santa Ana	CA
12020	Ovenaire, Incorporated	Charlottesville	VA
12143	Bendix Corporation	Santa Ana	CA
12405	Hysol Corporation	El Monte	CA
12406	Elnac, Incorporated	Fullerton	CA
12443	Omnimetra Mfg., Incorporated	Omaha	NE
12673	Weeco Electrical Co.	Greenfield	MA
12697	Clarostat Mfg. Co., Incorporated	Dover	NH
13103	Thermalloy Company	Dallas	TX
13434	Texas Crystals	River Grove	IL
13571	Electronic Research	Overland Park	KS
13919	Burr-Brown Research Corp.	Tucson	AZ
14099	Semtech Corporation	Newbury Park	CA
14193	Cal-R Inc.	Santa Monica	CA
14604	Elmwood Sensors Inc.	Cranston	RI
14655	Cornell-Dubilier Elect. Corp.	Newark	NJ
14674	Corning Glass Works	Corning	NY
14726	Heilingsworth Co.	Phoenixville	PA
14752	Electro Cube, Incorporated	San Gabriel	CA
14907	Cramer Div. of Genres	Old Saybrook	CT
15112	Electra Scientific Corporation	Fullerton	CA
15636	Elec-trol	Northridge	CA
15801	Fenwall Electronics	Framingham	MA
15818	Ameico Teledyne, Incorporated	Mt. View	CA
15909	Use Code #17870		
15912	Amelex	Los Angeles	CA
16067	California Instruments Company	San Diego	CA
16758	Delco Radio Div., General Motors	Kokomo	IN
16795	Bristol Electronics Inc.	Bedford	MA
16902	Simpson Instruments, Inc.	Escondido	CA
16950	Precision Dynamics Corp.	Burbank	CA
16956	Dewmoss	Framingham	ME
17745	Angstrom Precision, Inc.	Van Nuys	CA
17836	Mestrom, California General, Inc.	Chula Vista,	CA
17856	Siliconix	Santa Clara	CA
17870	Dawn Div., Thomas A. Edison	Manchester	NH
18076	Umpco	City of Industry	CA
18121	Wilshire Foam Products, Inc.	Gardena	CA
18178	Vactec Inc.	Maryland Heights	MO
18324	Signetics	Sunnyvale	CA
18612	Vishay Instruments Inc.	Malvern	PA
18677	Scambe Mfg. Co.	Monterey Park	CA
18702	Ducommun Metals and Supply Co.	Los Angeles	CA
18722	R C A	Mountaintop	PA
19088	The Robinson Company	Hawthorne	CA
19781	Power Company	San Valley	CA
20857	South Bay Cable Corp.	Gardena	CA
21270	Behr-Manning	Watervliet	NY
21604	Buckeye Stamping Company	Columbus	OH
22049	Jordan Elect.	Van Nuys	CA
22599	Elastic Stop Nut Corporation	Van Nuys	CA
23039	Deccoseit Products Company	Glendora	CA
23060	Product Components Corp.	Maatiegen-on-Hudson	NY
23094	Astec Electronics In.	Anaheim	CA
23783	British Radio Electric Ltd.	Washington	DC
23936	Pamotor, Incorporated	San Francisco	CA
24011	E C C	Burlington	MA
24655	General Radio	Concord	MA
24796	Pareico Inc.	Paramount	CA
24931	Specialty Connector Co., Inc.	Indianapolis	IN
25403	Amperex (Dioden)	Slatersville	RI
25446	Victoreen Instrument Co., Inc.	Oak Lawn	IL
26528	Lamcor Incorporated	Anaheim	CA
26433	Use Code #98376		
26806	American Zettler Inc.	Costa Mesa	CA
27014	National Semi-Conductor Corp.	Santa Clara	CA
27191	Cutler-Hammer, Inc.	Milwaukee	WI
27264	Molex	Downers Grove	IL
27556	IMB Electronic Products	Santa Fe Springs	CA
27683	Varo, Incorporated	St. Garland	TX
27832	Hughes Aircraft	Newport Beach	CA
28480	Hewlett-Packard Co.	Palo Alto	CA
28520	Heyman Mfg. Company (Heycal	Kenilworth	NJ
30086	I-T-E Circuit Breaker Co.	Philadelphia	PA
30817	Instrument Specialties Co.	Little Falls	NJ
30897	Derana Co.	Syimar	CA
30983	Electra/Midland (Mepco/Electra)	San Diego	CA
31743	Elpower	Santa Ana	CA
31991	Trivridge Inc.	Pittsburgh	PA
32293	Intersil	Cupertino	CA
34333	Silicon General	Westminister	CA
34649	Intel Corp.	Santa Clara	CA
35929	Constanta	Quebec	CN
42190	Muter Company	Chicago	IL
44655	Ohmite Manufacturing Company	Skokie	IL
45722	Parker-Kalon	Clifton	NJ
46384	Penn. Eng. and Mfg. Corp.	Doylestown	PA
49956	Raytheon Co.	Lexington	MA
50522	Monsanto, Electronic Special Products	Cupertino	CA
50558	Electronic Concepts Inc.	Eatontown	NJ
51705	ICO/Rally	Palo Alto	CA
52072	Circuit Assembly Corp.	Costa Mesa	CA
53209	W. H. Brady Co.	Milwaukee	WI
56289	Sprague Electric Company	North Adams	MA
57771	Stimson	Bayport	NY
58474	Superior Electric Company	Bristol	CT
59730	Thomas and Betts Company	Elizabeth	NJ
60741	Triplett Electrical Instrument Co.	Bluffton	OH
63743	Ward Leonard Electric Co.	Mt. Vernon	NY
70318	Allmetal Screw Prod. Co.	Garden City	NY
70903	Belden Manufacturing Co.	Chicago	IL
71002	Birnbach Radio Company, Inc.	New York	NY
71218	Bud Radio	Willoughby	OH
71279	Cambridge Thermionic Corp.	Cambridge	MA
71400	Bussman Mfg. Div. McGraw-Edison Co.	St. Louis	MO
71450	CTS Corporation	Elkhart	IN
71468	ITT Cannon Electric Inc.	Los Angeles	CA
71590	Centralab Div. Globe-Union, Inc.	Milwaukee	WI
71707	Cote-Coil	Providence	RI
71744	Chicago Miniature Lampworks	Chicago	IL
71785	Cinch Manufacturing Company	Chicago	IL
72136	Elmenco (Electro Motive)	Willimantic	CT
72259	Nytronics, Incorporated	Pelham Manor	NY
72619	Dialight Corporation	Brooklyn	NY
72699	General Instruments	Newark	NJ
72982	Erie Technological Products, Inc.	Erie	PA
73138	Beckman Instruments, Inc.	Fullerton	CA
73445	Amperex (Capacitors)	Long Island	NY
73559	Carling Electric, Inc.	West Hartford	CT
73734	Federal Screw Products, Inc.	Chicago	IL
73899	J F D Electronics Company	Brooklyn	NY
73949	Guardian Electric Mfg. Co.	Chicago	IL
73957	Groov-Pin Corporation	Ridgefield	NJ
74193	Heinemann Electric Company	Trenton	NJ
74278	Signalite, Incorporated	Neptune	NJ
74542	Hoyt Electrical Instrument Works	Penacook	NH
74545	Harvey Hubbell, Inc.	Bridgeport	CT
74970	E. F. Johnson Company	Waseca	MN
75382	Kulka Electric Corporation	Mt. Vernon	NY
75915	Littlefuse, Incorporated	Des Plaines	IL
75987	Use Code #95983		
76055	Mallory Controls	Frankfort	IN
76348	Miller Products Company	New York	NY
76385	Minor Rubber Co.	Bloomfield	NJ
76493	J. W. Miller Company	Los Angeles	CA
76854	Oak Manufacturing Company	Crystal Lake	IL
77342	Potter and Brumfield Div., Amer. Machine and Foundry Company	E. Princeton	IN
77638	General Instruments	Brooklyn	NY
77969	Rubber Craft Corp. of California	Torrance	CA
78189	Shakeproof Div., Illoms Tool Works	Chicago	IL
78299	Struthers-Dunn, Incorporated	Pitman	NJ
78488	Stackpole Carbon Company	St. Marys	PA
78526	Stanwyck Winding Company, Inc.	Newburgh	NY
78553	Timmerman Products, Inc.	Cleveland	OH
78947	Ucinite Company	Newtonville	MA
79110	Johns-Manville Products Corp.	Chicago	IL
79727	Continental-Wirr Electronics Corp.	Warminister	PA
79963	Zierick Mfg. Corporation	New Rochelle	NY
80031	Mepco/Electra	Morristown	NJ
80112	G. C. Electronics Company	Los Angeles	CA
80223	United Transformer Co.	New York	NY
80294	Bourns, Incorporated	Riverside	CA
80368	Sylvania Electric Products, Inc.	New York	NY
80583	Hammarlund Mfg. Co.	Red Bank	NJ
81073	Grayhill, Incorporated	La Grange	IL
81099	Triad Transformer Corp.	Venice	CA
81312	Winchester Electronics	Oakville	CT
81349	Military Spec., Standardization Division Directorate of Logistic Services DSA		
82104	Standard Grigsby	Aurora	IL
82389	Switchcraft, Incorporated	Chicago	IL
82877	Rotron Manufacturing Co., Inc.	Woodstock	NY
82893	Vector Electronics Inc.	Sylmar	CA
83058	Car Fastener Company	Cambridge	MA
83125	Nytronics Inc. Cap. Division	Darlington	SC
83298	Rosan, Incorporated	Newport Beach	CA
83330	Herman H. Smith, Inc.	Brooklyn	NY
83594	Burroughs Corporation	Plainfield	NJ
83701	Electronic Devices, Incorporated	Yonkers	NY
83781	Natl. Electronics	Geneva	IL
83827	Resistors Inc.	Chicago	IL
84171	Arco Electronics, Inc.	Great Neck	NY
84684	R C A	Harrison	NJ
84928	Sensatrom Mfg. Co.	Glendale	CA
87034	Marco-Oak Industries	Anaheim	CA
88026	Use Code #27191		
88245	Usoco Div., Litton Industries	Van Nuys	CA
89536	Fluke	Seattle	WA
90030	USM Corp.	Beverly	MA
90201	Mallory Capacitor Company	Indianapolis	IN
91459	Alcon Metal Prod. Inc.	Chicago	IL
91506	Augat	Attleboro	MA
91637	Dale Electronics, Inc.	Columbus	NE
91662	Elco Corporation	Willow Grove	PA
91812	Jamco Corporation	Burbank	CA
91833	Keystone Electronics Corp.	New York	NY
91929	Micro Switch Div., Honeywell, Inc.	Freeport	IL
92194	Alpha Wire Corporation	Elizabeth	NJ
92219	Waldom Electronics, Inc.	Chicago	IL
93332	Sylvania Electric Products, Inc.	Woburn	MA
94222	Southco, Incorporated	Lester	PA
95146	Alco Electronics Products	Lawrence	MA
95303	R C A	Cincinnati	OH
95348	Gordos Corp.	Bloomfield	NJ
95416	Use Code #95146		
95987	Weckesser Company, Inc.	Chicago	IL
96682	Gemtec, Incorporated	Compton	CA
96733	San Fernando Electric Mfg. Co.	San Fernando	CA
97525	Electronic Engineering Co.	Santa Ana	CA
97918	Limemaster Switch Corp.	Woodstock	CT
97966	U. S. Components, Incorporated	Bronx	NY
98159	Rubber Tech, Incorporated	Gardena	CA
98278	Microdot, Incorporated (Lercol)	S. Pasadena	CA
98291	Sealectro Corp	Mamaroneck	NY
98376	Zero Mfg. Co. (West)	Burbank	CA
98978	IERC	Burbank	CA
99028	Cleve	Gardena	CA
99378	Atlee Corp.	Woburn	MA
99392	3TM Corporation	Oakland	CA
99515	Marshall Industries	Monrovia	CA
99517	Vacco Industries	El Monte	CA
99707	Pharmacal Div., Johnson and Johnson	New Brunswick	NJ

ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS, Division of Norlin Industries, warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are tubes, fuses, and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned freight prepaid, and when examination reveals that the fault has not occurred because of misuse, abnormal conditions of operation, user modification, or attempted user repair. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS will submit an estimate for such charges before commencing repair if so requested.

PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS or its local representative, giving full details of the difficulty, and including the model number and serial number. On receipt of this information, service data or a Return Material Authorization (RMA) number will be given. Fil in RMA No. blank on shipping label attached opposite these instructions, pack instrument carefully to prevent transportation damage, affix label to shipping container, and ship freight prepaid to the factory. CALIFORNIA INSTRUMENTS shall not be responsible for repair of damage due to improper handling or packing. Instruments returned without RMA No., or freight collect will be refused. Instruments repaired under Warranty will be returned by prepaid surface freight. Instruments repaired outsi the Warranty period will be returned freight collect, F.O.B. CALIFORNIA INSTRUMENTS, San Diego, CA. If requested, an estimate of repair charges will be made before work begins on repairs not covered by the Warranty.

DAMAGE IN TRANSIT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed immediately with the carrier. A full report of the damage should be obtained by the claim agent, and a copy of this report should be forwarded to us. CALIFORNIA INSTRUMENTS will prepare an estimate of repair cost, and repair the instrument when authorized by the claim agent. Please include model number and serial number when referring to the instrument.

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